SUMMIT QX
2000 SERIES
800 MHz 75W-175W MULTI-NET REPEATER

Models: QX-RM82, QX-RM83
Part No.: 242-2008-132/134

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SUMMIT® QX
800 MHz MULTI-NET® REPEATER
PART NO. 242-2008-132/134

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The E.F. Johnson Company designs and manufactures two-way radio equipment to serve a wide variety of communications needs. Johnson produces equipment for the mobile telephone and land mobile radio services which include business, industrial, government, public safety, and personal users.

LAND MOBILE PRODUCT WARRANTY

The manufacturer's warranty statement for this product is available from your product supplier or from the E.F. Johnson Company, 299 Johnson Avenue, Box 1249, Waseca, MN 56093-0514. Phone (507) 835-6222.

WARNING

This device complies with Part 15 of the FCC rules. Operation is subject to the condition that this device does not cause harmful interference. In addition, changes or modification to this equipment not expressly approved by E. F. Johnson could void the user's authority to operate this equipment (FCC rules, 47CFR Part 15.19).

DO NOT allow the antenna to touch or come in very close proximity with the eyes, face, or any exposed body parts while the radio is transmitting.

To comply with FCC RF exposure limits, DO NOT operate the transmitter of a stationary radio (base station or marine radio) when a person is within four (4) meters of the antenna.

DO NOT operate the radio in explosive or flammable atmospheres. The transmitted radio energy could trigger blasting caps or cause an explosion.

DO NOT operate the radio without the proper antenna installed.

DO NOT allow children to operate transmitter equipped radio equipment.

NOTE: The above warning list is not intended to include all hazards that may be encountered when using this radio.

SAFETY INFORMATION

The FCC has adopted a safety standard for human exposure to RF energy. Proper operation of this radio under normal conditions results in user exposure to RF energy below the Occupational Safety and Health Act and Federal Communication Commission limits.

The information in this document is subject to change without notice.

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FCC EXPOSURE LIMITS

This fixed station radio transceiver was tested by the manufacturer with an appropriate antenna in order to verify compliance with Maximum Permissible Exposure (MPE) limits set under Section 2.1091 of the FCC Rules and Regulations. The guidelines used in the evaluation are derived from Table 1 (B) titled "Limits For General Population/ Uncontrolled Exposure" which is from FCC report OET bulletin #65.

Table 1 (B)
FCC Limits for Maximum Permissible Exposure (MPE)

(B) Limits For General Population/Uncontrolled Exposure			
Frequency Range (MHz)	**Electric Field Strength (E) (V/m)**	**Magnetic Field Strength (H) (A/m)**	**Power Density (S) (mW/cm^2)**
0.3 - 1.34	614	1.63	(100)*
1.34 - 30	824/f	2.19/f	$(180/f^2)$*
30 - 300	27.5	0.073	0.2
300 - 1500	--	--	f/1500
1500 - 100,000	--	--	1.0
f = Frequency in MHz*Plane-wave equivalent power density.			

Table 2 lists the antennas recommended for use in the VHF frequency range. Each model of this radio was tested with the appropriate antenna listed. The antenna shall be mounted to a tower and be a minimum of 10 meters above the ground at the lowest point on the antenna. The radio manufacturer has determined that the user and service personnel should remain four (4) meters in distance away from the antenna when transmitting. By maintaining this distance, these individuals are not exposed to radio frequency energy or magnetic fields in excess of the guidelines set forth in Table 1 (B).

NOTE: Other antennas or installation configurations that have not been tested may not comply with FCC RF exposure limits and therefore are not recommended.

Table 2
Recommended Antennas
(Antenna Manufacturer - Decibel Products)

Frequency	**Antenna Model No.**
132-144 MHz	DB205E
144-178 MHz	DB205F

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A 800 MHz CHANNEL FREQUENCY CHART

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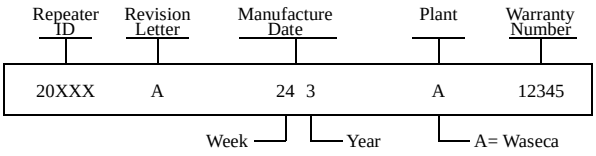
SECTION 1 INTRODUCTION AND OPERATION

1.1 SCOPE OF MANUAL

This service manual provides installation, operation, programming, service, and alignment information for the Summit® QX Repeater, Part No. 242-2008-132/134.

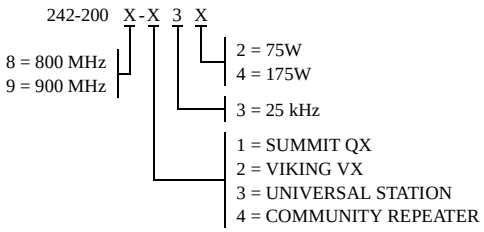
1.2 REPEATER IDENTIFICATION

The repeater identification number is printed on a label affixed to the inside of the repeater cabinet. The following information is contained in that number:



1.3 MODEL NUMBER BREAKDOWN

The following breakdown shows the part number scheme used for the Summit QX.



1.4 REPEATER DESCRIPTION

The Summit QX repeater is designed for operation in a Johnson Multi-Net system. It operates on the 800 MHz channels from 851-869 MHz (repeater transmit). The repeater receive frequencies are 45 MHz below these frequencies (806-824 MHz). Channel spacing is 25 kHz and RF power output is adjustable from 25 to 75 watts (Part No. 242-2008-132) or 75 to 175W with the high power amplifier.

This repeater is modular in design for ease of service. There are separate assemblies for the logic cards, receiver, exciter, power amplifier and power supply sections.

This repeater is programmed with a lap top or personal computer using the repeater software, Part No. 023-9998-297.

1.5 MULTI-NET SIGNALING

The repeater covered by this manual utilizes Multi-Net signaling. This signaling provides advanced features such as 8163 Unique ID codes, five levels of access priority, home channel back-up, and over-the-air mobile reprogramming. Multi-Net signaling and repeater control is provided by the Main Processor Card. The repeater connects to the RNT (Radio Network Terminal) or newer 3000 Series Switch, using a phone line or some other type of link. The RNT or Switch as referred to throughout this manaul provides overall system control (see Sections 1.14 and 5 for more information on Multi-Net equipment and features).

1.6 ACCESSORIES

The accessories available for the Viking VX LTR repeater are listed in Table 1-1. A brief description of some of these accessories follows.

Table 1-1 VIKING VX REPEATER ACCESSORIES

Accessory	Part No.
2000 Series Service Kit[1]	250-2000-230
Battery Back-Up Option[2]	023-2000-835
Reference Oscillator Splitter Shelf[3]	023-2000-924
Reference Oscillator Adapter Kit[4]	023-2000-923
Redundant OCXO	561-0006-012
Companding Module	023-2000-940
3' RG-58 BNC M-M HSDB cable	023-4406-505
6' RG-58 BNC M-M HSDB cable	597-3001-214
Custom Frequency Programming & Setup	023-2000-100
PC Programmer PGMR Software	023-9998-459
Service Microphone	589-0015-011
50 ohm Termination HSDB	023-4406-504
Telewave Combining Systems	
5-channel 115V AC[6]	585-1163-115
5-channel 230V AC[6]	585-1163-125
10-channel 115V AC[7]	585-1163-110
10-channel 230V AC[7]	585-1163-120
Duplexer (High Power Only)	585-1157-101
RF Lightning Protector	
Type-N Lightning Arrestor	585-0898-001
Polyphaser™	585-0898-005
Floor Mount 19" Open Rack***	
7' with accessories[5], setup and test	023-2000-216
7' 6" with accessories[5], setup and test	023-2000-217
8' with accessories[5], setup and test	023-2000-218
AC Power Distribution	
AC Power Strip 115V AC (1 per 2 rptrs)	597-1004-010
AC Power Stirp 230V AC (1 per 2 rptrs)	023-2000-212

[1] Includes: extender card, extender cables, TIC bias cable and programming cable kit.
[2] +26V DC input with cable.
[3] Required for more than eight channels.
[4] Interface to existing systems.
[5] Accessories include all mounting hardware, rack ground bar and wire to repeaters.
[6] These systems use two antennas and one additional rack (combining rack is included).
[7] These systems use three antennas and two additional racks (combining rack is included).

2000 Series Service Kit- This kit includes an extender card, extender cables, TIC bias cable and programming cable. These items are used when tuning the repeater and while troubleshooting.

Battery Backup Option - It includes the +26V DC battery backup module that resides in the power supply and the necessary interconnect cabling to connect the repeater to the batteries (see Section 2.5).

1:8 Splitter Shelf - This increases the number of outputs from an OCXO drawer (see Figure 2.12).

Reference Oscillator Adapter Kit - The kit is installed in the 1:8 Splitter Shelf. The attenuator is used in 2009 repeater systems when only one OCXO drawer is available.

Redundant OCXO - The OCXO (Oven Controlled Crystal Oscillator) drawer produces a stable 1.25 MHz (±0.1 PPM) reference signal for the Receiver and Exciter synthesizers.

Companding Module - This enhances the receive and transmit audio when used in conjunction with the Telephone Interface Card (TIC).

Three Foot Cable - This is a 3' RG-58 coax cable with BNC male connectors for the HSDB (High Speed Data Bus).

Six Foot Cable - This is a 6' RG-58 coax cable with BNC male connectors for the HSDB (High Speed Data Bus).

Custom Frequency - This is a factory frequency programming and repeater setup.

PGMR 2000 Programming Software - 3.5" programming disk used to program the repeater.

Service Microphone - This is a speaker and microphone combination that plugs into the MAC connectors. The microphone provides local audio and push-to-talk, while the speaker provides local audio adjusted with the volume control.

1.7 WARRANTY

The warranty statement for this transceiver is available from your product supplier or from the

Warranty Department
E.F. Johnson Company
299 Johnson Avenue,
Box 1249,
Waseca, MN 56093- 0514

This information may also be requested by phone from the Warranty Department as described in Section 1.8. The Warranty Department may also be contacted for Warranty Service Reports, claim forms, or any questions concerning warranties or warranty service by dialing (507) 835-6222.

1.8 FACTORY CUSTOMER SERVICE

The Customer Service Department of the E.F. Johnson Company provides customer assistance on technical problems and the availability of local and factory repair facilities. Regular Customer Service hours are 7:30 a.m. - 5:30 p.m. Central Time, Monday - Friday. The Customer Service Department can be reached using one of the following telephone numbers:

Toll-Free: (800) 328-3911
(From within continental United States only)

International: (507) 835-6911

FAX: (507) 835-6969

E-Mail: First Initial/Last Name@transcrypt.com
(You need to know the name of the person you want to reach. Example: dthompson@transcrypt.com.)

NOTE: Emergency 24-hour technical support is also available at the 800 and preceding numbers during off hours, holidays, and weekends.

When your call is answered at E.F. Johnson Company, you will hear a brief message informing you of numbers that can be entered to reach various departments. This number may be entered during or after the message using a tone-type telephone. If you have a pulse-type telephone, wait until the message is finished and an operator will come on the line to assist you. When you enter some numbers, another number is requested to further categorize the type of information you need.

You may also contact the Customer Service Department by mail. Please include all information that may be helpful in solving your problem. The mailing address is as follows:

E.F. Johnson Company
Customer Service Department
299 Johnson Avenue
P.O. Box 1249
Waseca, MN 56093-0514

1.9 FACTORY RETURNS

Repair service is normally available through local authorized E.F. Johnson Land Mobile Radio Service Centers. If local service is not available, the equipment can be returned to the factory for repair. However, it is recommended that you contact the Customer Service Department before returning equipment because a service representative may be able to suggest a solution to the problem so that return of the equipment would not be necessary.

Be sure to fill out a Factory Repair Request Form #271 for each unit to be repaired, whether it is in or out of warranty. These forms are available free of charge by calling the repair lab (see Section 1.7) or by requesting them when you send a unit in for repair. Clearly describe the difficulty experienced in the space provided and also note any prior physical damage to the equipment. Then include a form in the shipping container with each unit. Your telephone number and contact name are important because there are times when the technicians have specific questions that need to be answered in order to completely identify and repair a problem.

When returning equipment for repair, use a PO number or some other reference number on your paperwork in case you need to call the repair lab about your unit. These numbers are referenced on the repair order and it makes it easier and faster to locate your unit in the lab.

Return Authorization (RA) numbers are not necessary unless you have been given one by the Field Service Department. RA numbers are required for

exchange units or if the Field Service Department wants to be aware of a specific problem. If you have been given an RA number, reference this number on the Factory Repair Request Form sent with the unit. The repair lab will then contact the Field Service Department when the unit arrives.

1.10 REPLACEMENT PARTS

E.F. Johnson replacement parts can be ordered directly from the Service Parts Department. To order parts by phone, dial the toll-free number as described in Section 1.7. When ordering, please supply the part number and quantity of each part ordered. E.F. Johnson dealers also need to give their account number. If there is uncertainty about the part number, include the designator (C112, for example) and the model number of the equipment the part is from.

You may also send your order by mail or FAX. The mailing address is as follows and the FAX number is shown in Section 1.7.

E.F. Johnson Company
Service Parts Department
299 Johnson Avenue
P.O. Box 1249
Waseca, MN 56093-0514

1.11 INTERNET HOME PAGE

The E.F. Johnson Company has a home page on the World Wide Web that can be accessed for information on such things as products, systems, and regulations. The address is http://www.efjohnson.com.

1.12 SOFTWARE UPDATES/REVISIONS

All inquiries concerning updated software, its installation and revisions should be directed to the Customer Service Department (see Section 1.7).

1.13 AREPEATER OPERATION

1.13.1 MAIN PROCESSOR CARD (MPC)

Refer to Figure 1-2.

Programming Jack

J1 provides input connection from the computer and the "flash memory" in the MPC. The programming information in an IBM® personal computer programs the MPC directly from the serial card through interconnect cables connected to the COM1 or COM2 port.

Reset

S1 provides a manual reset of the Main Processor Card (MPC). A manual reset causes a complete power-up restart.

Display and LEDs

Each combination of DS1 display read-out and CR4/CR3 indication refers to an active alarm. See Table 1-2 for alarms and definitions. When CR1 is blinking, the MPC is operational. When CR2 is on, it indicates a high power repeater, off is low power. When CR5 is on, it indicates this is an LTR repeater, off is a Multi-Net repeater.

Alarms

When the Repeater is in the test mode the safety measures are disabled. Therefore, if the Repeater is keyed for an extended period with a blocked fan and the power amplifier temperature increases, thermal shutdown will not occur. There are pop-up windows that will appear in the Test mode screens to alert the user that there is an alarm and action should be taken. Refer to Figure 1-1 for an example of this type of alarm.

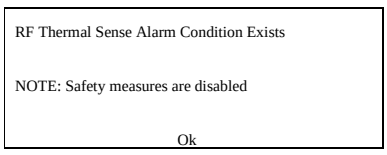


Figure 1-1 ALARM IN TEST MODE

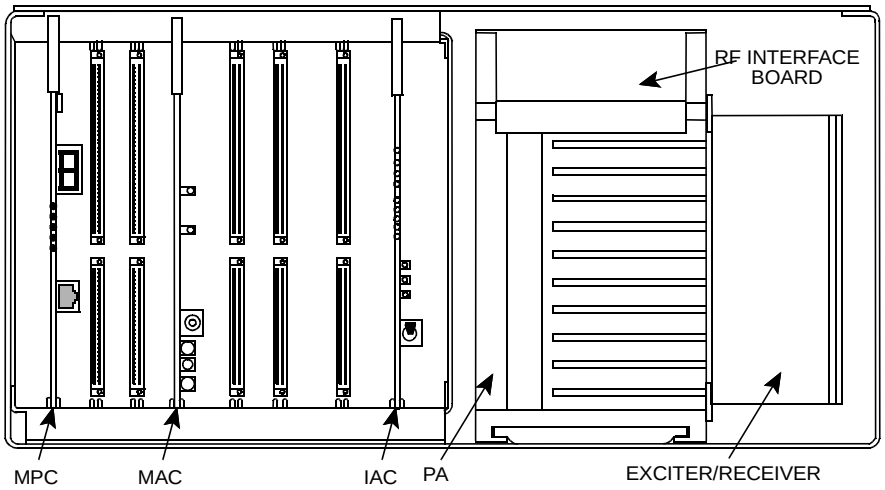


Figure 1-2 REPEATER CARDS

Table 1-2 ACTIVE REPEATER ALARMS

Alarm No.	DS1	CR3	CR4	Definition
0	0	Off	On	Test Mode
1	1	Off	On	IAC input 1 Active
2	2	Off	On	IAC input 2 Active
3	3	Off	On	IAC input 3 Active
4	4	Off	On	IAC input 4 Active
5	5	Off	On	IAC input 5 Active
6	6	Off	On	IAC input 6 Active
7	7	Off	On	IAC input 7 Active
8	8	Off	On	IAC input 8 Active
9	9	Off	On	MAC Processor Alarm
10	A	Off	On	HSDB Processor/Cable Alarm
11	B	Off	On	IRDB Cable Alarm
12	C	Off	On	Switch (RNT)/CIM Channel Problem Alarm
13	D	Off	On	TIC Processor Alarm
14	E	Off	On	MMC Processor Alarm
15	F	Off	On	VNC Alarm
16	0	On	Off	AC Power Failure
17	1	On	Off	Battery Power Failure
18	2	On	Off	Power supply thermal sense
19	3	On	Off	Fan 1 current out of specification
20	4	On	Off	Fan 2 current out of specification
21	5	On	Off	IAC mismatch
32	0	On	On	RF shutdown
33	1	On	On	RF Half Power Mode
34	2	On	On	Thermal sense in RF portion
35	3	On	On	RF Finals 1-2 power out failure
36	4	On	On	RF Finals 3-4 power out failure
37	5	On	On	RF VSWR Failure
38	6	On	On	Normal Synthesizer Tx Lock failure
39	7	On	On	Normal Synthesizer Rx Lock failure
40	8	On	On	HS Synthesizer Tx Lock failure
41	9	On	On	HS Synthesizer Rx Lock failure
42	A	On	On	RF Quarter Power Alarm

1.13.2 MULTI-NET AUDIO CARD (MAC)

Refer to Figure 1-2.

- External Speaker Jack

  J104 provides repeater audio output to an external speaker. The local volume control adjusts the volume level of this speaker.

- Speaker/Microphone Jacks

  J102 provides audio input from a microphone. J101 provides the receive audio to the speaker.

- Local On/Off/Volume Control

  R236 controls the receive audio output to J101 and J104. Turning this control clockwise past the detent applies voltage to the local audio amplifier.

- A D Level Test Point

  J100 provides audio/data level output for test level checks.

- Ground

  J103 is connected to ground for test equipment when monitoring test point J100.

1.13.3 INTERFACE ALARM CARD (IAC)

Refer to Figure 1-2.

- Voltage Test Output

  J502 provides a test point to monitor +15V supply on the IAC.

- Ground

  J501 is connected to ground for test equipment when monitoring voltage test point J502.

- A D Level Test Point

  J500 provides a test point to monitor audio and data levels, AC fail and thermal sensor.

- Power Supply On/Off Switch

  S508 turns the power supply DC voltages on and off from the front of the repeater.

- Power Indicators

  CR501 indicates the +5V supply is at normal level and applied to the IAC. CR524 indicates the -5V supply is at normal level and applied to the IAC. CR523 indicates the +15V accessory supply is at normal level. CR525 indicates that the +15V supply is at normal level and applied to the IAC.

- CWID Indicator

  Indicates that the CW Identification is being transmitted on the lowest-frequency repeater. The CWID is a continuous-wave (CW) transmission of the station call letters in Morse code to satisfy the station identification requirement. The CWID is programmed into the repeater memory. This indicator also is used when an alarm is transmitted with Morse code.

- Hang Indicator

  Indicates that the hang word is being transmitted by the repeater. This word is transmitted on calls in which the channel is held for the duration of the call and not just for the duration of the transmission. The hang word tells the mobiles to stay on the same channel and not re-access the system when responding to a call.

- Switch Call Indicator

  Indicates that an Switch-to-Mobile transmission is in progress.

- Mobile Call Indicator

  Indicates that a mobile-to-repeater transmission is in progress.

- Xmit Indicator

  Indicates that the repeater transmitter is keyed by the logic.

1.13.4 POWER SUPPLY

The 2000 Series Repeater Power Supply is a quad output 800W supply with power factor correction. A battery back-up module, PN 023-2000-830, can be added to the power supply to provide automatic battery revert in the event of AC power failure (see Section 2.5) The Battery Back-Up module charges the batteries when AC is present at the power supply (see Section 2.4 and 8.5).

1.14 MULTI-NET SYSTEM COMPONENTS

1.14.1 INTRODUCTION

The main components in a Multi-Net system are shown in Figure 1-3. A Multi-Net system can be designed to meet the requirements of almost any user. The following are Multi-Net features.

- With Multi-Net signaling, advanced features such as up to 8163 Unique ID codes, automatic mobile identification, home channel backup, and five levels of access priority are available.

- Users of different types of radio equipment can talk to each other. Example: a conventional mobile channel could talk to a mobile operating on a Multi-Net (trunked) 800 MHz channel.

- Wide area radio coverage can be provided so that a mobile could talk to another mobile that is using a repeater that may be hundreds of miles away. That repeater may be part of the same Multi-Net system or another Multi-Net system. Phone line or other types of links can be used to provide the communication path.

Multi-Net systems are not restricted to a specific type of signaling. Example: an entire Multi- Net system could be designed using conventional channels which use tone- or digitally-controlled squelch. The various types of signaling can also be mixed in a system. Example: there could be ten channels using Multi-Net signaling, ten channels using LTR® signaling, and ten channels using conventional signaling. Check with your Johnson representative for more information concerning the capabilities of Multi-Net systems.

The following Sections provide a brief description of the Multi-Net components see Figure 1-3.

1.14.2 MOBILE TRANSCEIVERS

The mobile and handheld transceivers used in a Multi-Net system must be compatible with the type of signaling in use and also the frequency range.

Multi-Net transceivers can be programmed for LTR and conventional operation. However, some LTR transceivers can only be programmed for LTR and conventional operation. The main difference between Multi-Net and LTR only versions of the same model is the software in the microprocessor.

1.14.3 REPEATERS

NOTE: The Summit QX does not require a separate Multi-Net logic drawer.

The repeater model used in a Multi-Net system is determined by frequency range. 800 MHz systems use the Summit QX. There is one repeater for each RF channel.

- Inter-Repeater Data Communication

  Data communication between Multi-Net or LTR repeaters is via a high-speed data bus. This bus cable is installed in a daisy-chain manner between repeaters. If both Multi-Net and LTR repeaters are located at a site, only like types are connected together. Up to 30 Multi-Net or 20 LTR repeaters can be interconnected (see Section 2.9 for connecting the data bus).

- Repeater Connection To Switch
  The repeaters can be located at the same site as the Switch or they may be located at a site that is many miles from the Switch. A voice and data link is required between the repeaters and Switch. This link can be a direct connection, phone lines, microwave, RF transceiver, fiber optic, or some other type of link. This link is connected to the repeater terminal block on the back of the repeater.

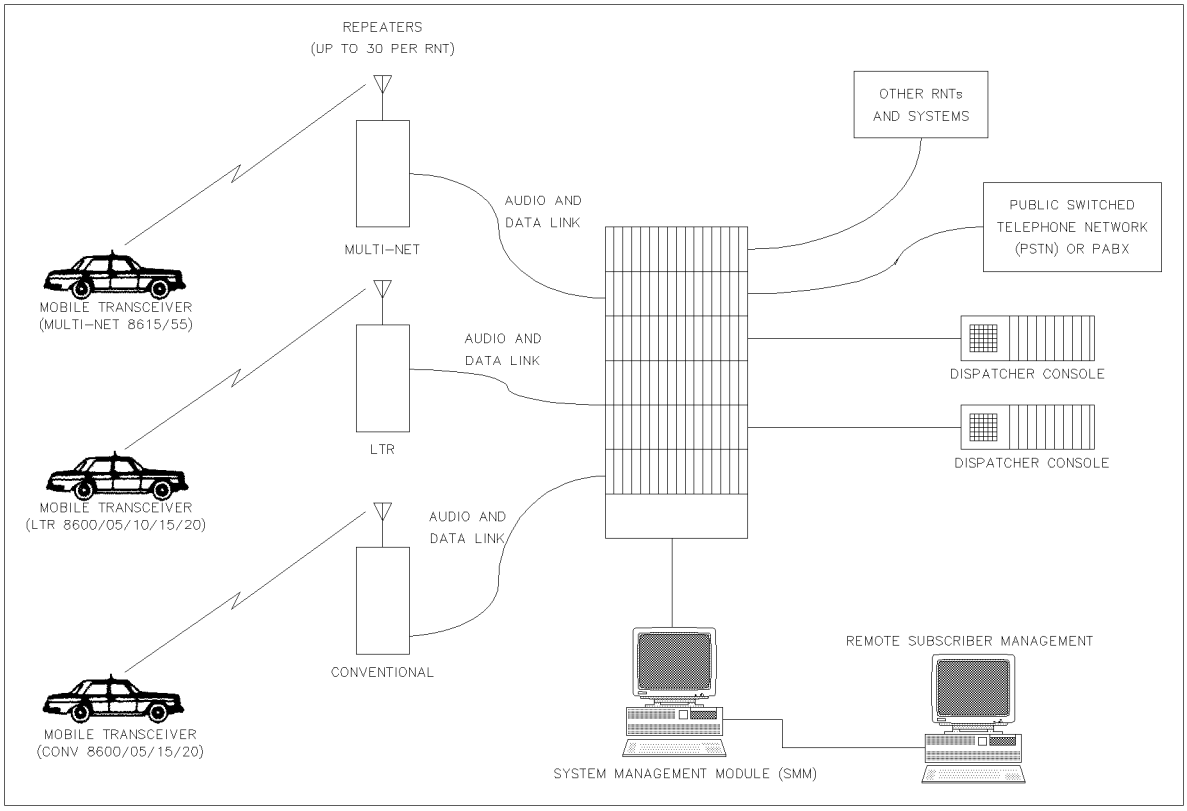


Figure 1-3 MULTI-NET SYSTEM COMPONENTS

The voice link routes transceiver voice to and from the Switch. The voice must be routed to the Switch when a call involves a dispatcher, telephone interconnect, or another RF channel or Multi-Net system. If the call is a mobile-to-mobile call on the same RF channel, the voice is simply repeated by the repeater (it is also routed to the Switch but is not connected to anything). The voice path input/output port interfaces with a standard 4-wire, 600 ohm phone line.

The data link allows the Switch to control the repeater. With mobile-to-repeater calls, the data fed to the Switch is used to determine what routing is required for the call. On Switch-to-Mobile calls, the data fed to the repeater allows the Switch to operate the repeater like a base station.

There are three different types of links that can be selected for the data path between each repeater and the Switch. The MPC is programmed for the type of link used (see Section 2.9).

- A 4-wire voice-grade link can be used that is similar to the audio link. The data is then sent as tones using FSK modulation.
- RS-232 serial inputs and outputs are available for direct connection or connection to a link that accepts RS-232 data.
- Data can be modulated as in '1' and then sent over the voice path using a blank and burst technique. Only one 4-wire link is then needed between each repeater and the Switch.

1.14.4 3000 SERIES SWITCH

The 3000 Series Switch (or RNT) along with the System Management Module (SMM) or newer Call Processor (CP) control the Multi-Net system. The Call Processor (or SMM) is connected to the Switch and it is an IBM PC or compatible computer running special Multi-Net software. It is used by the system manager to program and control Switch operation. The Call Processor also continuously monitors Switch operation and maintains usage information for billing purposes. Such activities as dynamic reprogramming of mobiles and disabling of lost or stolen mobiles are performed by the system manager using the CP.

A single Switch can control up to 30 repeaters. It contains one Channel Interface Module (CIM) for each repeater it controls, and one Trunk Interface Module (TIM) for each telephone line used for interconnect calls. It also contains a Dispatch Interface Module (DIM) or Intelligent Dispatch Module (IDM) for each dispatch console. Refer to the RNT Setup and Alignment Manual, Part No. 001-3039-009 or the 3000 Series Switch Setup and Alignment Manual, Part No. 001-3139-001 for more Switch/RNT information. Schematics, PC board component layouts and Parts Lists are in either RNT Service Manual, Part No. 001-3039-101 or 3000 Series Switch Service Manual, Part No. 001-3139-100.

1.14.5 DISPATCH CONSOLES

One or more dispatch consoles can be connected to the Switch using direct connection, phone lines, or some other type of link. Depending on the capabilities of the particular console, the dispatcher can perform such functions as placing calls to specific transceivers, placing calls to other dispatchers or patching together transceivers.

1.14.6 PUBLIC SERVICE TELEPHONE NETWORK (PSTN)

If interconnect calls are to be placed by transceivers, the Switch is connected to the public service telephone network. The System Manager determines which can place calls and other interconnect parameters when programming the Call Processor and by the programming of each transceiver.

1.15 MULTI-NET OPERATION

Multi-Net signaling allows the addition of many new enhanced operating features that are not available with LTR or conventional signaling. Multi-Net systems are described in the information which follows. For information on LTR signaling operation, refer to the LTR Application Note, Part No. 009-0001-020 (revision 7 or later).

1.15.1 HOME AND STATUS REPEATERS

When a mobile transceiver is programmed, it is assigned to both a "Home" and "Status" repeater. A mobile in the standby mode continuously monitors one of these repeaters for control information. This information is used to detect incoming calls, which repeater is free, the current access priority, and other information. Refer to Section 1.15.4 for more information on status repeaters, and to Section 1.16.3 for more information on access priority.

A Home repeater transmits continuous update messages when it is in use or if any of its mobiles are trunked out to another repeater. During idle times, these repeaters transmit update messages every 10 seconds. The status repeater transmits continuous update messages when any repeater at the site is in use. Therefore, a mobile just coming into service does not miss a call in progress.

If the repeater being monitored is not busy, it is used to make a call. Otherwise, the call may be trunked to any repeater at the site to make a call. Group ID codes 1-225 are assignable on each Home repeater for dispatch calling. Therefore, in a 10 channel system, up to 2250 different Group ID codes can be assigned. ID codes 226-254 are reserved for special calls (see Sections 1.16.1 and 1.16.2).

1.15.2 MOBILE-REPEATER DATA SIGNALING

NOTE: "Mobile" as used in this manual describes any mobile transceiver, whether hand held or mounted in a vehicle.

Mobile control is accomplished by the exchange of data messages between the mobile and repeater. This data signaling can occur continuously with voice because it is at the subaudible frequency of 150 Hz.

Therefore, no dedicated control channel is required, and all channels can be used for voice communication for maximum system efficiency.

When a mobile makes a call, a data "handshake" with the repeater tells the mobile in half a second the system has been successfully accessed. It also ensures that the signal is not occurring on the wrong channel because of intermodulation. A handshake also prevents a mobile with a stronger signal from capturing a used channel.

A repeater is held for only the duration of the transmission with dispatch calls, so an entire conversation consisting of several transmissions may occur on several different channels. This technique, called transmission trunking, provides maximum system efficiency because others can use the time between transmissions. Special calls, i.e. telephone, hold the repeater for the duration of the call.

The calls that can be placed and received are determined by the ID codes programmed into the transceiver by the system operator. Therefore, other users in the system cannot eavesdrop on conversations of other groups. Although traffic can be monitored by a receiver tuned to the channels being used, that may even be difficult because of the transmission trunking just described.

1.15.3 REPEATER DATA BUS SIGNALING

A high-speed serial data bus interconnects the MPCs of the repeaters at a site. Control information is exchanged between repeaters via this bus. Multi-Net repeaters utilize a logic control technique called distributive processing in which the logic in each repeater performs all the control functions on that channel. This control technique eliminates the need for a separate controller at each site. All repeaters are connected to the Switch by a separate data link as described in Section 1.14.3.

When a repeater is in use, it places information on the data bus which includes the Home repeater number and the Group and Unique ID code of the mobile using the channel. This information is monitored by the other repeaters to determine which repeater is free and also to determine if any of their mobiles are trunked to other repeaters.

If a mobile is trunked to another repeater to receive a call, additional data messages are transmitted continuously by that mobile's Home repeater, the Status repeater (see Section 1.15.4), and the repeater to which the mobile was trunked. The messages on the Home and Status repeaters tell mobiles just coming into service which repeater to switch to in order to receive the call. Messages on the repeater being used by the transceiver keep it updated on what calls are being received by other mobiles assigned to its Home repeater. Therefore, calls with a higher receive priority are not missed, even when trunked to another repeater.

The sequence of data messages transmitted on a Home or Status repeater is as follows: Every third data message is the message to the mobile using that repeater. Then alternating between those messages are the messages to the other mobiles. In the case of a Home repeater, these messages are sent to its mobiles being trunked out to other repeaters. In the case of the Status repeater, messages to all other mobiles currently using the site are transmitted in addition to those messages (if mobiles have been assigned to it). For example, assume that five different transceivers are making calls. If all have Repeater 1 as their Home repeater (not very likely in actual practice), the data message order on Repeater 1 is as follows; 1 2 3 1 4 5 1 2 3 and so on. Therefore, in this case, the maximum number of data messages that occur before repeating is six.

Repeater data bus synchronization is done distributively. Therefore, no single repeater is responsible for data bus synchronization. If any one or more repeaters at the site become inoperative, the others continue to operate normally.

1.15.4 HOME CHANNEL BACKUP

DEFINITIONS

The following terms and definitions are used in this section and elsewhere in this manual.

- System

  Normally applies to the systems selectable by the transceiver system select switch. Each selectable system can be programmed with a different Home repeater, Group ID codes, and other transceiver operating parameters.

- Site

  A set of repeaters connected to the same high-speed data bus.

- Status Repeater

  One repeater at each site using Multi-Net signaling is designated to transmit update information for all calls occurring at that site. This repeater is also available for voice traffic, but is normally not assigned as a Home repeater.

- Home repeater

  All transceivers have one of the site repeaters assigned as their "Home" repeater. The Home repeater/Group ID information is used to identify mobiles when standard dispatch calls are placed.

- Monitor Repeater

  This is the repeater that a mobile is currently monitoring for update messages which may be either the mobile's Home repeater or the site Status repeater. The monitor repeater is always used to place a call unless it is busy. When it is busy, the mobile may be trunked to any other site repeater to make the call. This repeater is selected randomly.

INTRODUCTION

If mobiles are limited to just their Home repeater to receive update information and it is inoperative, all mobiles assigned to that Home repeater are unable to place or receive calls. To prevent this, each site using Multi-Net signaling has one repeater which provides backup for all the other repeaters. This repeater is called a "Status" repeater and it transmits update messages for all calls occurring at the site. All mobiles assigned to that site can receive update messages from either the Status repeater or their Home repeater. Therefore, if a repeater fails, the transceivers assigned to that Home repeater monitor the Status repeater for update information needed to place and receive calls.

- Site Number and Status Channel Assignment

  Each selectable system of a mobile is programmed with the number of the site that is accessed by that system. For proper mobile operation, the same Status channel must be programmed in all systems which access the same site. For example; if systems 1, 3 and 4 access site 128, those systems must be programmed with the same Status channel. Mobiles normally are not assigned to the Status repeater because they would not have Home channel backup. However, if the ID codes of the Status repeater are needed, they can be assigned without any loss in system calling efficiency.

- Selecting the Repeater to Monitor

  Each selectable system of a mobile is programmed with Home and Status repeater channel numbers. Which repeater to monitor is determined by scanning both when transceiver power is turned on. When valid data is detected, that channel becomes the monitor channel until valid data is no longer detected or a system programmed for a different site is selected. The repeater being monitored does not affect transceiver performance.

- Detecting Defective Repeaters

  If a repeater is defective, it is important that it is taken off the air as quickly as possible to ensure that all transceivers are receiving quality service. To detect improper operation, calls are periodically placed through a test mobile by the Call Processor. A test mobile is simply a transceiver located off-site that has attenuated power output. These calls use the Interrogate special call described in Section 1.16.5, and they are placed through each repeater in the site. This call exercises the repeater RF receive, RF transmit, and MPC circuitry. The faulty repeater may then be automatically or manually shut down by the Call Processor.

1.16 MULTI-NET FEATURES

1.16.1 STANDARD AND SPECIAL CALLS

There are two types of calls with Multi-Net signaling; Standard Calls and Special Calls. Group ID codes 1-225 are Standard (dispatch) calls, and Group ID codes 226-255 are Special Calls.

As previously stated, up to 225 Group ID codes are assignable on each Home repeater. When a transceiver monitors its Home or Status repeater, it receives data messages containing a Home repeater number, Group ID, and Unique ID code (refer to Section 1.16.2). When it detects its Home repeater and a

Group ID from 1-225 that it is programmed to decode, it unsquelches and the call is received. The correct Unique ID code does not need to be detected to receive a Standard Call. Standard Calls are limited to other transceivers assigned to the same Home repeater. However, each selectable system of a transceiver can be programmed with a different Home repeater to allow calls to mobiles assigned to other Home repeaters if desired.

If a Group ID from 226-255 is received, a Special Call is indicated and the transceiver will respond according to the type of call. Special calls are used to perform many of the special Multi-Net features described in this section. Examples of Special Calls are calls to a specific transceiver (Unique ID) or Group (Directed Group). Others are Interrogate, Interconnect, and Transceiver Disable. Generally, a transceiver must decode its Unique ID code to respond to a Special Call.

1.16.2 UNIQUE ID CODES

Each transceiver is programmed with a Unique ID code in addition to Group ID codes. Unique ID codes are assigned on a system-wide basis, not on a repeater basis as with Group IDs. Up to 8163 Unique ID codes can be assigned per Switch.

Whenever a transceiver makes a call, it always transmits its Unique ID in addition to a Group ID. Any control point equipped with a decoder and display capable of listening to that transceiver can then display the ID of that unit. This provides automatic identification of transceivers making calls.

Unique IDs also permit individual mobile units to be called using the special calls described in the preceding section. Calls can also be made to individual transceivers using standard call Group IDs 1-225 if an ID is assigned to only one transceiver.

1.16.3 ACCESS AND RECEIVE PRIORITY

The priority access feature allows users that have a greater need to communicate, access to the system first. There are 5-levels of priority, with 1 the highest priority and 5 the lowest priority. Each repeater determines the current priority level and then transmits the priority information in the data messages to the transceivers that are monitoring it.

When a transceiver is programmed, a priority level (1-5) is assigned to each Group ID that is encoded (transmitted). The algorithm used by the repeater to determine the current priority is selected by programming software. If the priority level transmitted by the repeater is higher than that programmed for the selected group, a busy indication is produced and the system cannot be accessed.

There is also a priority order when receiving messages if the selected system of the transceiver is programmed with two or more receive Group ID codes. This permits a call with a higher priority ID code to interrupt a call with a lower priority ID code. Receive priority occurs only with standard dispatch calls. Telephone and other special calls cannot be interrupted by standard calls. Refer to the operation section of the transceiver service manual for more information on receive priority.

1.16.4 ALL CALL

"All Call" is one of the special calls described earlier. This call is received by all mobiles assigned to the site because it goes out to all repeaters simultaneously and has the highest priority. Therefore, all calls in progress are dropped to receive it. An All Call message can be transmitted by the system operator or by a dispatcher that is authorized to do so. If a mobile is turned on, the only time that this message can be missed is while it is in the transmit mode.

1.16.5 INTERROGATE

A dispatcher with the proper authority can interrogate any mobile unit in the field. A special interrogate message is sent that contains the Unique ID code of the affected mobile. If that mobile is turned on, it will automatically transmit a message back to the dispatcher that identifies it and sends one of eight status indications which are then displayed at the dispatch point. This feature can be used for such things as determining if a transceiver is in service or assisting in the recovery of lost or stolen units. It is also used to detect defective repeaters as described in Section 1.15.4.

1.16.6 MOBILE DISABLE

If a transceiver is lost, stolen, interfering with communications or known to be monitoring sensitive transmissions, it can be permanently disabled by the System Manager. After the mobile disable message is sent, verification returns by the transceiver indicating that it has been successfully disabled. To make the transceiver operational again, it must be brought back in and reprogrammed.

1.16.7 DYNAMIC REPROGRAMMING OF GROUP 11

Group 11 of each selectable system of a mobile can be dynamically reprogrammed over the air. Group 11 is the only one that can be reprogrammed over the air (it can also be programmed normally). Making only one group reprogrammable over the air prevents the transceiver from becoming inoperative if a programming error occurs because of a poor RF signal. Dynamic reprogramming is performed by the system manager. The data transmitted to the mobile includes the selectable system to be changed, the new encode and decode ID codes, and the access priority of the encode code. One use of this feature is to allow a transceiver to make or receive calls for which it was not originally programmed.

1.16.8 DYNAMIC MOVE TO NEW SYSTEM/ GROUP

The dynamic reprogramming feature described in the preceding section does not change the selected group of the transceiver. This can be done using the dynamic move to System/Group special call. The procedure is similar to that used for dynamic reprogramming. When this message is detected by the mobile, it automatically switches to the System/Group number contained in the message. One use of this feature is to make sure that mobiles are set to the correct System/ Group to receive an important "All Call" message. It can also be used along with the dynamic reprogramming command to send a special message.

1.16.9 ID VALIDATION

ID validation is the process that ensures only the mobiles authorized service on the system, use the system. The System Management Module checks both Group and Unique ID codes. If an unauthorized ID code is detected, a turn-off code is transmitted to the mobile or mobiles receiving the call. This effectively disables the unauthorized mobile because it cannot talk to any other mobiles.

1.16.10 INTERCONNECT CALLS

Mobiles may place telephone calls on the Public Service Telephone Network using the Interconnect special call. When the System Management Module detects a mobile placing an interconnect call, it checks to see if it is authorized that service, and what type of call it is making. If it is authorized, the Switch completes the connection to the PSTN. The Call Processor performs the record keeping for billing.

1.16.11 SYSTEM KEY

The system repeaters and all mobiles are programmed with a unique System Key. The function of the System Key is to ensure that only authorized users can access a Multi-Net system. The repeater System Key is programmed at the factory, and the mobile system key is programmed into the transceiver by the system operator. The System Key is a number which is used by both the repeaters and the mobiles to encode the data stream. Unless both are programmed with the proper key, communication is not possible. The System Key used to program the mobiles is provided to the system operator by the E.F. Johnson Company.

1.16.12 DYNAMIC CHANNEL ASSIGNMENT

When channels (repeaters) are added to a Multi-Net system, mobiles do not have to be brought back in for reprogramming. The reason for this is that mobiles are informed over the air as to which channel number to use to place or receive a call. The only channel numbers programmed into the mobiles are the Home and Status channels.

1.16.13 EMERGENCY CALLS

An optional emergency switch is available on Multi-Net portables for emergency situations to quickly place calls or transmit an emergency code.

The portable can be programmed so that the emergency message is transmitted either automatically or manually. When automatic operation is programmed, the portable automatically transmits the programmed emergency code on the designated

System/Group until an acknowledgment is received from the dispatcher. When manual operation is programmed, the portable goes to the designated System/Group. Then when the user presses the push-to-talk switch, the system is accessed at the highest priority and a message can be transmitted. Refer to the operation section of the portable service manual for more information on emergency switch operation.

1.16.14 VOTER SYSTEM

The Multi-Net Voter System may be used to enhance the ability to receive calls from mobiles on the fringes of the coverage area. A voter system utilizes satellite receivers located at outlying sites. When a mobile places a call, the receiver with the strongest signal is determined and then that receiver is connected to the repeater handling the call. IF a receiver with a higher RSSI is detected, it will switch to that site.

SPECIFICATIONS

GENERAL*

Frequency Range	806-824 MHz Receive, 851-869 MHz Transmit
Dimensions	9.125" H x 17" W x 20.9" D
AC Voltage/Frequency	100-240V AC/50-60 Hz
AC Current (Low Power)	0.40A (Standby), 1.7A (25W), 2.8A (75W)
AC Current (High Power)	0.40A (Standby), 3.8A (75W), 5.8A (175W)
AC Input Power (Low Power)	45W (Standby), 199W (25W), 328W (75W)
AC Input Power (High Power)	45W (Standby), 445W (75W), 680W (175W)
DC Current at 26.5V DC (Low Power)	5.2A (25W), 9.8A (75W)
DC Current at 26.5V DC (High Power)	11.5A (75W), 19.5A (175W)
Number of Channels	1 (Synthesized, programmable)
Channel Spacing	25 kHz
Channel Resolution	12.5 kHz
Temperature Range	-30°C to +60°C (-22°F to +140°F)
Duty Cycle	Continuous
FCC Type Acceptance	ATH2422008, ATH2422008-1
FCC Compliance	Parts 15, 90

RECEIVER

12 dB SINAD	0.35 µV
20 dB Quieting	0.50 µV
Signal Displacement Bandwidth	±2 kHz
Adjacent Channel Rejection	-85 dB
Intermodulation Rejection	-80 dB
Spurious & Image Rejection	-90 dB
Audio Squelch Sensitivity	12 dB SINAD
Audio Response	+1/-3 dB TIA
Audio Distortion	Less than 3% at 0.5W/16 ohms
Local Audio Power	0.5W/16 ohms
Audio Sensitivity	±1.5 kHz
Hum & Noise Ratio	-45 dB
Frequency Spread	6 MHz
Frequency Stability	±1 PPM -30°C to +60°C (-22°F to +140°F)

TRANSMITTER

RF Power Out (Low Power)	75W (Default setting), 25W (Variable Set Point)
RF Power Out (High Power)	175W (Default setting), 75W (Variable Set Point)
Spurious Emissions	-90 dBc
Harmonic Emissions	-90 dBc
Audio Deviation	±3.5 kHz
Multi-Net Data Deviation	±1 kHz
CWID Deviation	±2 kHz
Repeat Deviation	±1.5 kHz
Audio Response	+1/-3 dB TIA
Audio Distortion	Less than 2%
Hum & Noise (TIA)	-45 dB
Frequency Spread	6 MHz
Frequency Stability	±1 PPM -30°C to +60°C (-22°F to +140°F)
Emission Designators	14K0F3E, 16K0F3E, 14K0F3D, 16K0F3D, 14K0F1D, 16K0F1D

SECTION 2 INSTALLATION

2.1 INTRODUCTION

Information in this section tells how to set up the repeater for operation in a Multi-Net system. It is assumed that the repeater has been previously aligned at the factory or as described in the alignment procedure in Section 7.

Even though each repeater is thoroughly aligned and tested at the factory, it is good practice to check performance before it is placed in service. This ensures that no damage occurred during shipment and that the repeater is otherwise operating properly. Performance testing is described in Section 7.5.1.

2.1.1 SITE PREPARATION AND ANTENNA INSTALLATION

Site preparation and antenna installation are not within the scope of this manual. Basic installation requirements are discussed in the "Dealer Guide To Site Preparation", Part No. 004-8000-101. Factory installation is also available. Contact your Johnson representative for more information.

2.2 ENVIRONMENT

The following conditions should be considered when selecting a site for the Repeater.

Operating Temperature

-30°C to +60°C (-22°F to +140°F).

Humidity

Less than 95% relative humidity at 50°C.

Air Quality

For equipment operating in a controlled environment with the repeaters rack mounted, the airborne particles must not exceed 30 $\mu g/m^3$.

For equipment operating in an uncontrolled environment with the repeaters rack mounted, the airborne particles must not exceed 100 $\mu g/m^3$.

NOTE: If the repeater is installed in an area that exceeds these environmental conditions, the site should be equipped with air filters to remove dust and dirt that could cause the equipment to overheat.

When the repeaters are installed in an environment that contains small airborne particles, e.g. grain dust or salt fog, the repeater cabinets need to be sealed. A heat exchanger, i.e. air conditioner, is then required to cool the cabinets. The air conditioners must be suited for the environment. Each repeater (175W) requires >3100 BTU/hr dissipation to maintain exterior cabinet temperature.

2.3 VENTILATION

The RF modules and the power supply are equipped with fans, controlled by thermostats, that force air through the equipment for cooling. The air flow is from the front to the back of the equipment. This permits the repeaters to be stacked or rack mounted (see Figure 2-4). There are a few considerations when installing Repeaters to provide adequate air circulation.

- The repeaters should be mounted with a minimum of 6 inches clearance between the front or back of the cabinet for air flow. The power supply requires a minimum of 18 inches at the back of the repeater for removal.

NOTE: Repeaters should not touch, leave a minimum of one empty screw hole (approximately 1/2") between repeaters vertically especially for bottom ventilation slots in high power repeaters.

- Cabinet enclosures must provide air vents for adequate air circulation.

- Temperature and humidity must be considered when several repeaters are installed at a site. This might require air conditioning the site.

2.4 AC POWER

The AC power source to the Johnson Summit QX Repeater can be 120V AC to 240V AC. Nothing need be done to the power supply for nominal 240V AC operation. However, using a 240V AC outlet requires replacement of the 120V AC power plug. A locking AC power cord is provided.

The 120V AC cord is a standard 3-wire grounded cord used with a standard AC wall outlet. The outlet must be capable of supplying a maximum of 328W (-132) or 680W (-134). With the nominal 120V AC input, the source must supply 3A for each 75W repeater or 6A for each 175W repeater and should be protected by a circuit breaker. It is recommended that all of the repeaters in a rack should not be on the same breaker in order to provide one operational repeater in the event a breaker trips. An AC surge protector is recommended for all equipment.

Each repeater requires an outlet and the receiver multicouplers require one each, so for a 5-channel system, a minimum of 7 outlets is required. An additional three should be added for test equipment. The outlets must be within 3 feet of each repeater cabinet. Future system expansion should be considered when electrical work is being planned for the initial system.

The power supply can be equipped with an optional 24V DC back-up in the event of AC power failure. Since the transmitter will remain on full power, if desired, the DC power source must have a current capability of about 15A per 75W repeater (25A per 175W repeater) or 75A for 5-75W repeaters (125A for 5-175W repeaters). The multicoupler requires another 0.5A for a total system requirement at 24V DC of 75.5A for 75W repeaters (125.5 for 175W repeaters).

2.5 BATTERY BACKUP

If the power supply is equipped with battery backup, screw lugs are provided on the front of the power supply for battery connections (see Figure 2-1). A switch is provided for charging the battery or can be off if a separate battery charger is used. A battery temperature sensor connection is also provided. The temperature sensor cable is shown in Figure 2-2. LED indicators are provided to show Reverse Battery connection, Charger On/Off and Battery Fault.

The temperature sensor is required to adjust the charging voltage over temperature.

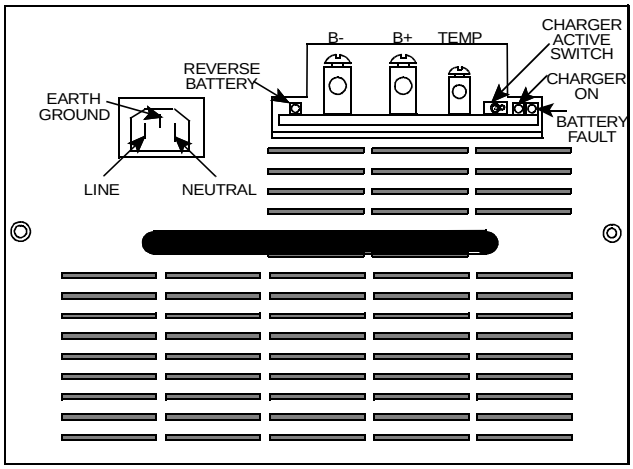


Figure 2-1 POWER SUPPLY INSTALLATION

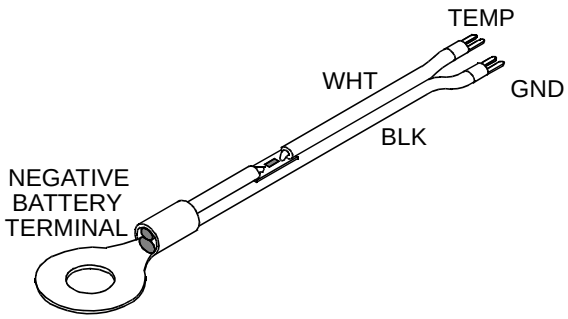


Figure 2-2 TEMPERATURE SENSOR CABLE

2.6 800W POWER SUPPLY

The power supply has four voltage output levels (see Table 2-1). Each voltage is set to ±1% at +25°C (+77°F). The output of this supply is capable or running any 2000 series repeater.

Each output is overload protected such that the power supply current limits and automatically resets when the overload is removed (see Table 2-1).

Each output is over voltage protected such that the power supply shuts down when an over voltage condition exists, usually when a component in the supply has failed (see Table 2-2). The power supply must be manually reset by toggling the Enable Line or removing AC power for more than 10 seconds.

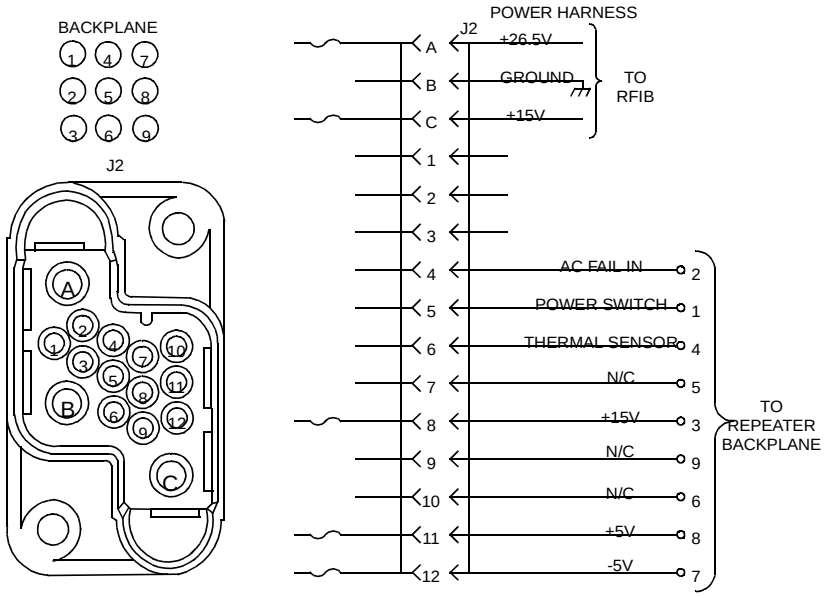


Figure 2-3 POWER CABLE CONNECTOR AND SCHEMATIC

Table 2-1 OUTPUT VOLTAGES

Voltage	Current	Wattage
+26.5V	22A	583W
+15V	5A	75W
+5.2V	5A	26W
-5V	1A	5W

Table 2-2 OVER VOLTAGE

Voltage	Range
+26.5V	+32V to +33V
+15V	+16V to +18V
+5.2V	+6V to +7V
-5V	-6V to -7V

2.6.1 AC INPUT REQUIREMENTS

AC Input Voltage:	100-240V AC
Line Frequency:	50-60 Hz
AC In-rush:	60A maximum
Overall Efficiency:	>70% at 100V AC
	>80% at 240V AC
Lightning protection:	6kV for < 1ms
Power Factor:	>0.97 at full load
Brown Out Voltage:	80V AC
Temperature	-30°C - +60°C (full power)

Power factor correction per IEC555. The Power supply has the following safety agency approvals pending: UL1950, CSA22.2-950, TUV EN60950 (IEC950)

When the AC input voltage is below 90V AC, the maximum output power is decreased to keep the input current constant. If a battery back-up is installed, the batteries take over when the AC input voltage falls below 80V AC (dependant on power output).

The AC input connector is an IEC connector equipped with a locking mechanism.

The operating temperature range is -30°C to +60°C (-22°F to +140°F), i.e. the same as the repeater. The fan is thermostatically controlled by the internal temperature. When the internal heatsink temperature reaches +45°C (113°F) the fan turns on. When the heatsink temperature drops below +35°C (95°F) the fan turns off. If the internal heatsink temperature reaches +90°C (+194°F) the power supply turns off until the heatsink temperature drops below +85°C (+185°F). The over-temperature shutdown and restart are automatic.

2.7 GROUNDING

C A U T I O N

PROPER SITE GROUNDING AND LIGHTNING PROTECTION ARE VERY IMPORTANT TO PREVENT PERMANENT DAMAGE TO THE REPEATER.

As in any fixed radio installation, measures should be taken to reduce the possibility of lightning damage to the Summit QX equipment. Proper grounding eliminates shock hazard, protects against electromagnetic interference (EMI) and lightning.

Ground each piece of equipment separately. Do not ground one piece of equipment by connecting it to another grounded piece of equipment.

A good DC ground must be found or created at the site. Rooftop site grounds can be researched through the building management or architects. Tower site grounds must be made with grounding rods. The many techniques for providing adequate grounds for towers and poles and for installing building ground bus lines are beyond the scope of this manual. Refer to National Electrical Code article 250 "Grounding Techniques," article 800 "Communications Systems" and follow local codes.

The ground bus should be routed to the floor area within 5 feet of the system with a runner of 6 AWG or larger solid copper wire or 8 AWG stranded copper wire.

The outer conductor of each coaxial transmission line at the point where it enters the building should be grounded using 6 AWG or larger solid copper wire or 8 AWG stranded wire.

Secondary protection (other than grounding) provides the equipment protection against line transients that result from lightning. There are two types of secondary protection, RF and telephone line. Use the same wire sizes as specified for coaxial cables for any ground connections required by the secondary protectors.

2.7.1 RF GROUNDING

An RF protector keeps any lightning strike to the antenna feed line or tower from damaging the repeaters. Install this protection in-line with the combiner and antenna feed line.

RF protectors are selected by calculating the maximum instantaneous voltage at the output of the combiner. Do this by using the following equation.

$V_P = 1.414 (X) (\sqrt{P(50)})$

Where:
V_P = Voltage at the output of the combiner.
P = repeater output in watts

X=	for	VSWR=
1.05		1.10 : 1
1.09		1.20 : 1
1.13		1.30 : 1
1.17		1.40 : 1
1.20		1.50 : 1
1.30		1.86 : 1

Example: Repeater power output of 60W with a VSWR of 1.3 : 1 (for this VSWR, X = 1.13):

$V_P = 1.414 (1.13) (\sqrt{60(50)})$
$V_P = 1.59782 (\sqrt{60(50)})$
$V_P = 1.59782 (54.772256)$
$V_P = 87.52$

2.7.2 TELEPHONE LINE GROUNDING

There are four types of protection suppressors for telephone lines; gas tube, silicon avalanche diode, metal oxide varistor and hybrid.

The hybrid protector is ideal for repeater equipment, and is strongly recommended. A hybrid suppressor combines several forms of protection not available in just one type of device. For example, a high-speed diode reacts first clamping a voltage strike within 10 ns, a heavy duty heat coil reacts next to reduce the remainder of the current surge, and a high-powered three-element gas tube fires, grounding Tip and Ring.

2.7.3 PROTECTION GUIDELINES

Follow these guidelines for grounding and lightning protection. Each repeater installation site is different; all of these may not apply.

- Ensure ground connections make good metal-to-metal contact (grounding rod, grounding tray, metal conduit) using #6 gauge solid wire or braided wire straps.

- With surge protectors, ensure that ground wires go directly to ground, not through other equipment.

- Run the ground wire for RF coax protectors directly to ground.
- With coax protectors, ensure maximum instantaneous voltage does not exceed the rated voltage.
- Do not run ground wires parallel to any other wiring (e.g. a ground wire parallel to a telephone line), except other ground wires.
- Double check all equipment for good ground and that all connections are secure.

2.8 UNPACKING AND INSPECTION

E.F. Johnson ships the repeater securely crated for transportation. When the repeater arrives, ensure the crates remain upright, especially if storing the crates temporarily.

When unpacking the repeater, check for any visible damage or problems caused by shipping. If there is obvious damage from shipping mishaps, file claims with the carrier. If there appears to be any damage caused before shipping, file a claim with E.F. Johnson. Contact Customer Service for assistance (see Section 1.8).

If everything appears undamaged, remove the repeater equipment from the crate, using normal precautions for unpacking.

NOTE: Do not discard the packing materials. If you must return an item, use the same packing materials and methods (including static protective bags for circuit cards) to repack the equipment. You are responsible for proper repacking. E.F. Johnson cannot be responsible for damage to equipment caused by negligence.

NOTE: Repeaters should not touch; leave a minimum of one empty screw hole (approximately 1/2") between repeaters vertically especially for bottom ventilation slots in high power repeaters.

NOTE: Each repeater should be grounded separately by connecting a ground bus from the ground lug on the back side of the RF module to the ground bar on the rack (see Figure 2-8).

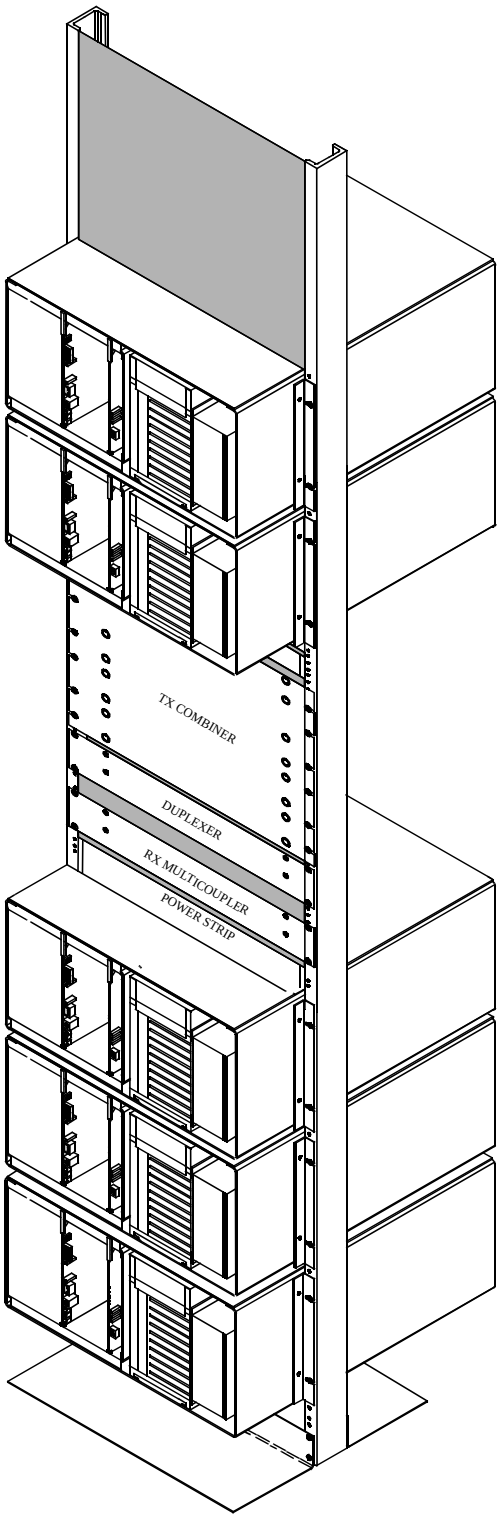


Figure 2-4 RACK MOUNTED REPEATERS

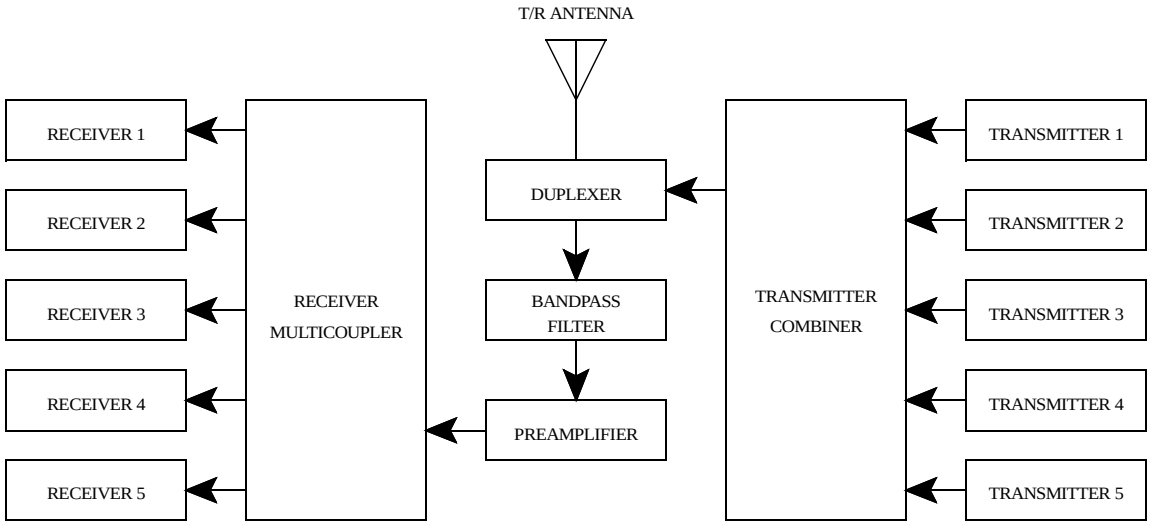


Figure 2-5 FIVE-REPEATER COMBINING SYSTEM

2.9 REPEATER DATA BUS INSTALLATION

The repeaters are interconnected by a balanced line High-Speed Data Bus (HSDB) consisting of a six conductor cable. The total length of the HSDB cannot exceed 500 feet. Connect the cables in daisy-chain fashion to modular connector A5 on the back of the repeater (see Figure 2-17). A 50 ohm termination is not required for SUMMIT QX repeaters.

2.9.1 MPC DATA BUS SWITCH SETTINGS

Switch settings on the MPC for the two types of installations require S2 and S3 sections to be switched as indicated in Figure 2-6.

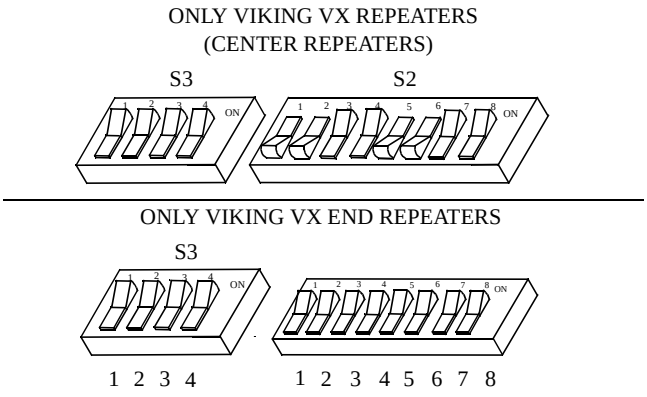


Figure 2-6 MPC DATA BUS SWITCHES

2.9.2 MPC DATA BUS JUMPERS SETTINGS

Refer to Figure 2-8 for crystal selection and HSDB Code selections jumper placement. Jumper J5, pins 1-2 selects 11.059 MHz for Multi-Net (J5, pins 2-3 selects 12 MHz crystal for Standard LTR). The jumper on J4, pins 5-6 connects EPROM U14, pin 27 to ground for Multi-Net (J4, pins 3-4 connects EPROM U14, pin 27 (A14) to +5V for Standard LTR single-ended 5V data bus).

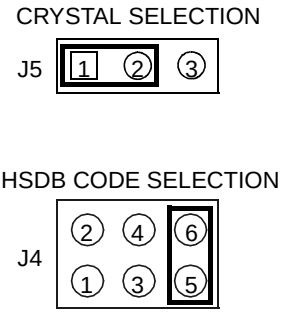


Figure 2-7 MPC JUMPERS

Jumper J4 must be placed with the following guidelines: J4, pins 5-6 for operation with the RJ-11 to RJ-11 cable with 2008 only systems.

2.10 CONNECTING RECEIVE AND TRANSMIT ANTENNAS

Receive and transmit antenna connector locations are shown in Figure 2-8. Although each transmitter and receiver could be connected to a separate antenna, this is usually not done because of the large number of antennas required by a multiple repeater installation. Therefore, an antenna combining system is usually used. An example of a combining system for a five-channel system is shown in Figure 2-5. The amount of power loss introduced by a combiner depends on the type of combiner used. If it has a loss of 3 dB, power output to the antenna is reduced by half.

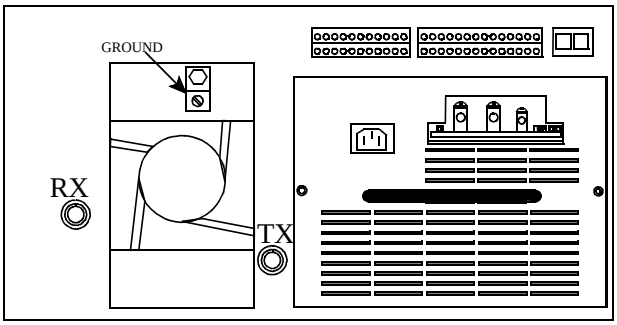


Figure 2-8 ANTENNA CONNECTIONS

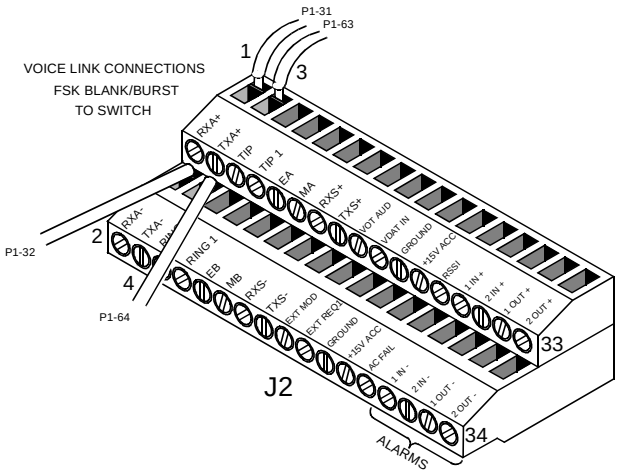


Figure 2-9 TERMINAL BLOCK J2

2.11 CONNECTING AUDIO/DATA LINK TO SWITCH

A communication link of some type is required between the Switch and each repeater. This link allows the Switch to control the repeater and also routes audio between the Switch and repeater. Various types of links can be used, such as phone line, RF transceiver, microwave, or fiber optic. Refer to Section 1.14.3 for more information. The repeater connection point is terminal block J2 on the back panel (see Figures 2-9, 2-13 and 2-14). The information which follows describes the installation of these links.

2.11.1 VOICE LINK

The voice link is always connected and it should be a standard 4-wire, 600 ohm balanced voice- grade link. It can be non-metallic, i.e. DC continuity is not required. If the repeaters and Switch are located at the same site, direct connection can be used as long as the line is less than approximately 300 feet.

Connect the voice link to terminals 1-2 and 3-4 (see Figure 2-9 and 2-13).

2.11.2 DATA LINK

One of these three methods can be used for installing the data link.

NOTE: See Section 7 for Link Alignment.

1. Separate 4-wire link can be used that is similar to that used for voice. The data is then encoded by FSK and sent as tones.

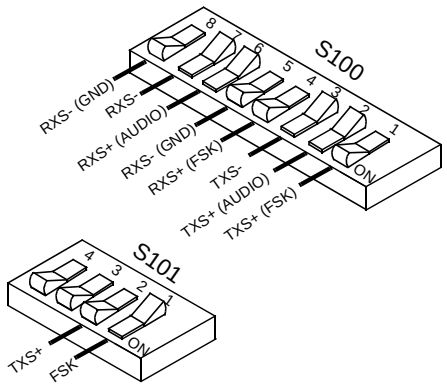


Figure 2-10 MAC DIP SWITCH SETTINGS FOR 4-WIRE LINK

2. A separate RS-232 serial link can be used.

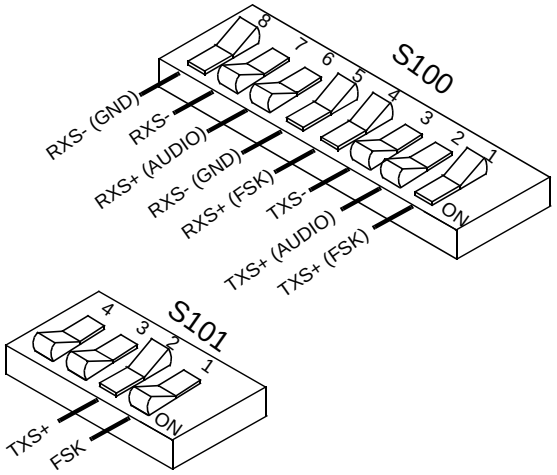


Figure 2-11 MAC DIP SWITCH SETTINGS FOR RS-232 LINK

3. The FSK data can be sent over the voice link using a Blank and Burst technique. No separate data link is then required.

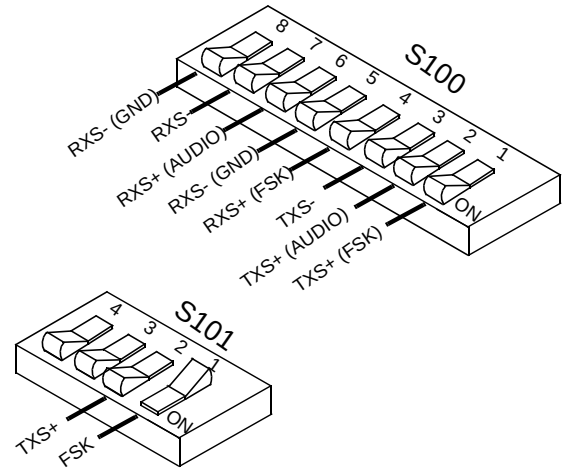


Figure 2-12 MAC DIP SWITCH SETTINGS FOR BLANK AND BURST LINK

Select the type of link being used, refer to Figure 2-9 and 2-13 and make the connections to terminals 1-2 and 3-4.

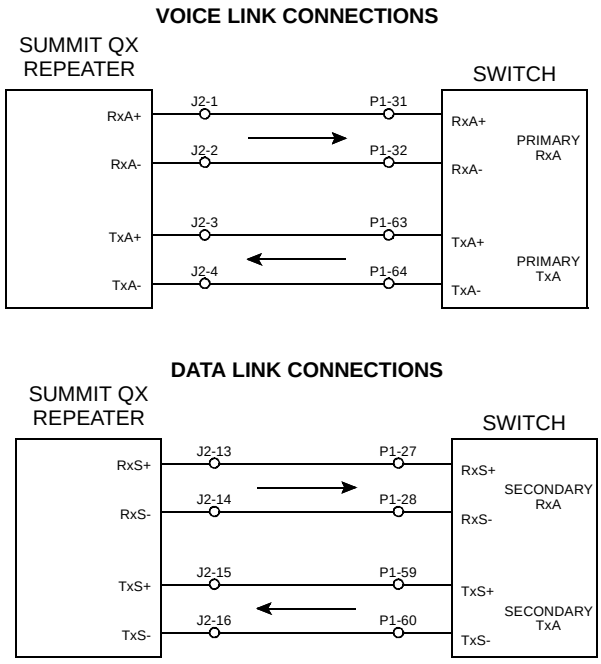


Figure 2-13 SUMMIT QX VOICE/DATA LINK

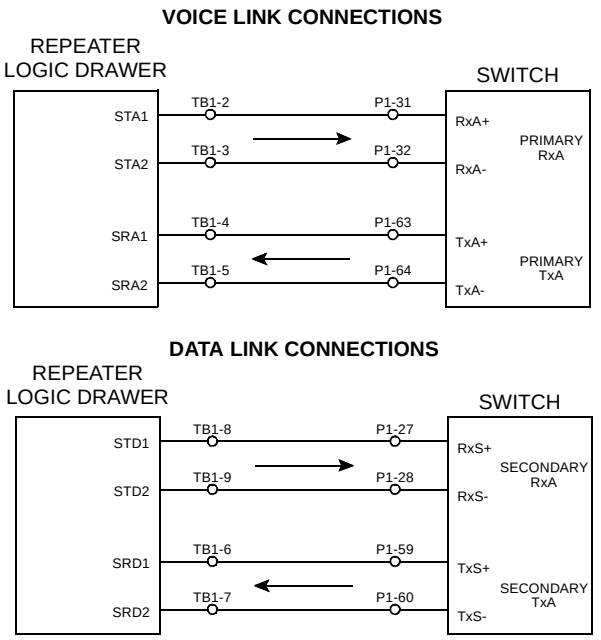


Figure 2-14 MULTI-NET VOICE/DATA LINK

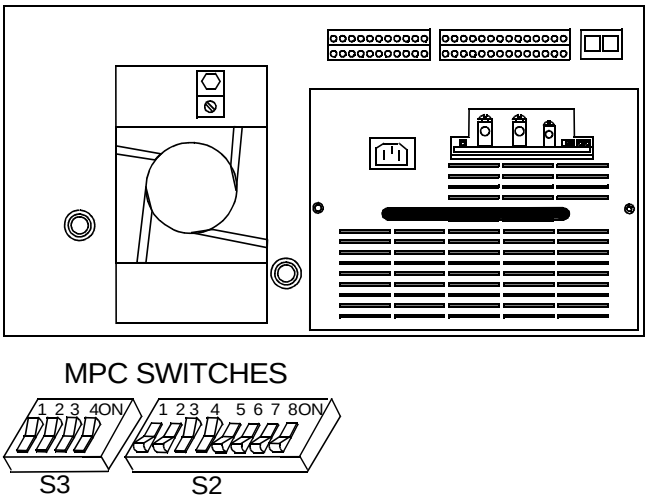


Figure 2-15 SINGLE REPEATER INSTALLATION

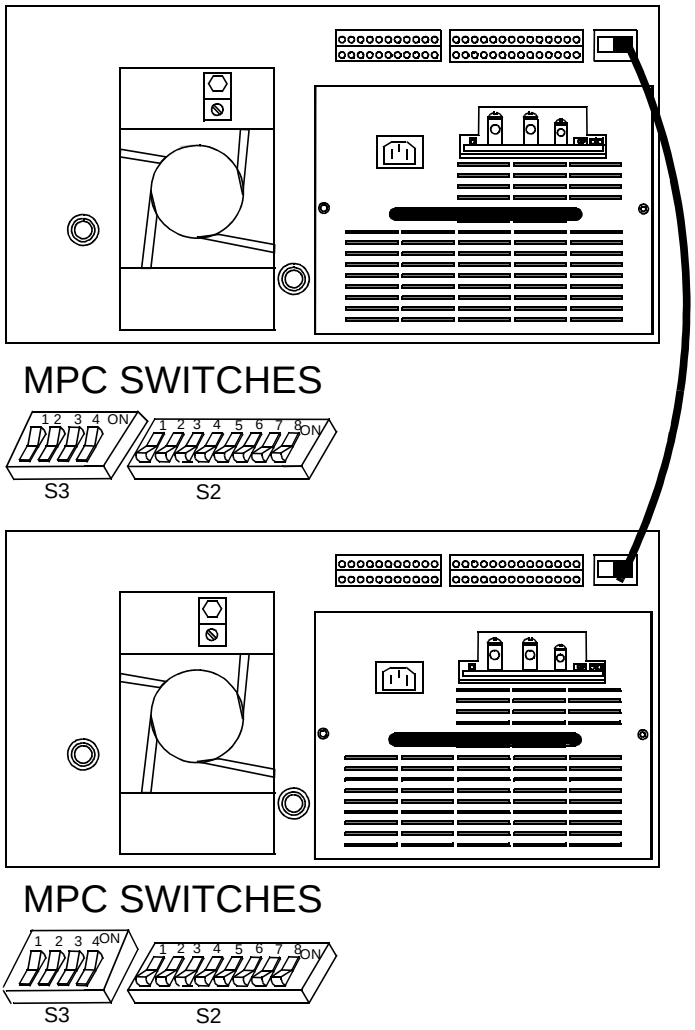


Figure 2-16 TWO REPEATER INSTALLATION

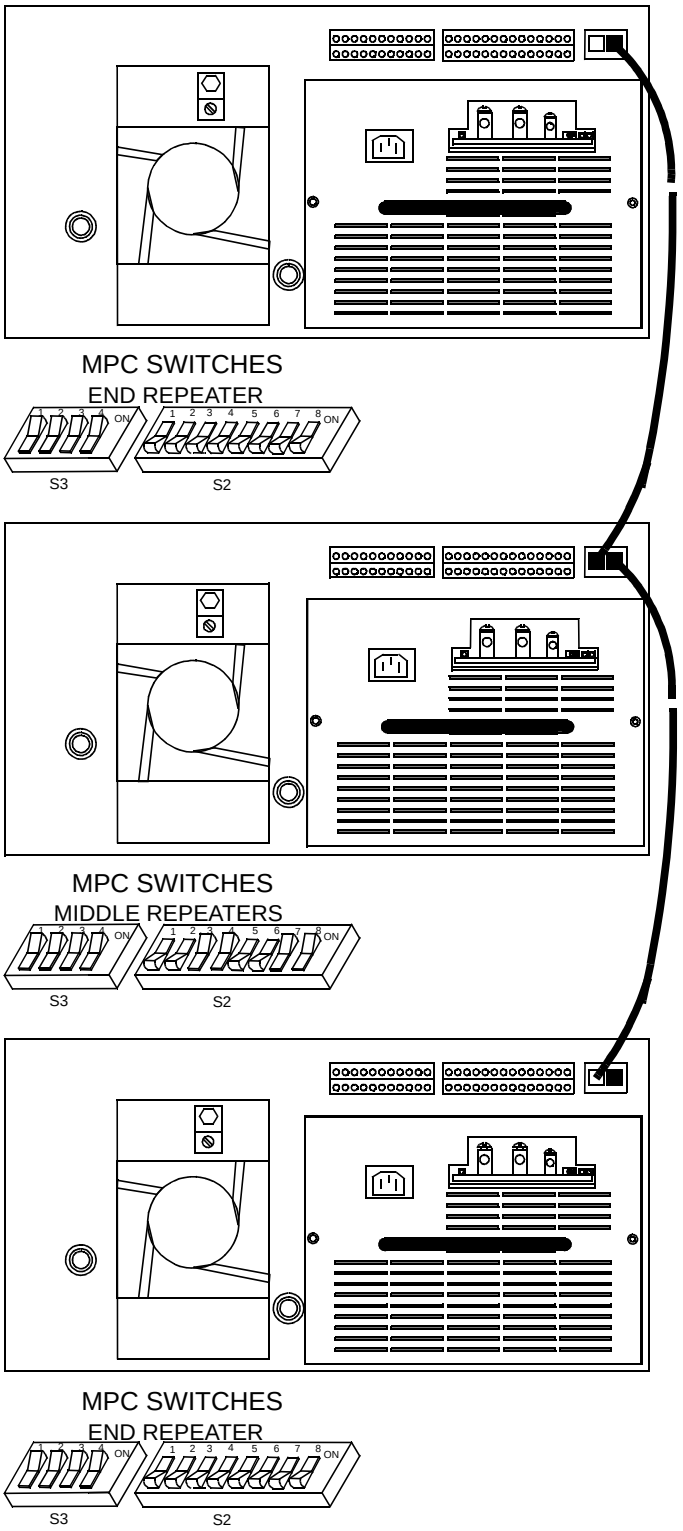


Figure 2-17 THREE OR MORE REPEATERS INSTALLATION

SECTION 3 SOFTWARE

3.1 INTRODUCTION

The Johnson Summit QX Repeater Program on 3.5 inch disk, Part No. 023-9998-297, uses an IBM® personal computer to program the EEPROM Memory in the Main Processor Card (MPC). To lessen the chance of programming errors and simplify operation, the program uses yes/no questions or toggles through the available responses.

The computer is connected directly from the serial card to the MPC. The interconnect cables used are shown in Figure 4-30. The DB-9 to 8-pin modular adapter is connected to the serial port of the computer and an interconnect cable connects the adapter to the MPC.

NOTE: These connections are for the IBM computer and may differ from an IBM compatible. In which case, consult the manuals for your computer for serial card outputs and connections.

3.1.1 HOW TO USE THIS MANUAL

This manual introduces the program and illustrates how to use the features. This manual is organized to easily find programming information with the Table of Contents, Index and Parameter Tables for the responses required for programming.

Graphic reproductions of the screens are shown for reference. Adjacent to the screens are tables to provide the parameters, available responses and a brief description of the parameter. It is not the intent of this manual to teach computer operation, but to allow the user to become familiar with the available screens and the responses without having to be at the computer.

3.1.2 GETTING STARTED

NOTE: Before starting you should already know how to start MS-DOS®, format and make backup copies of disks, copy and delete files, and run programs. If you are unfamiliar with any of these actions, refer to the MS-DOS manual for your computer for more information (see Section 5).

Follow the computer instructions for loading the disk. The MS-DOS Revision 2.0 or later operating system is needed to run the programs. The computer needs to have RS-232C capability, for example, the Serial Card in slot "COM1" or "COM2".

3.1.3 COMPUTER DESCRIPTION

The programming software is designed to run on an IBM PC or compatible computer that meet the following minimum requirements.

- One 3.5" high density disk drive
- 640K of memory
- MS-DOS version 2.0 or higher
- One serial port
- Monochrome or color monitor and video card

Although the program uses color to highlight certain areas on the screen, a monochrome (black and white) monitor or LCD laptop also provide satisfactory operation. Most video formats such as EGA and VGA are supported. A serial port is required to connect the repeater to the computer. This port is standard with most computers.

The cables from the repeater to the computer are not included. With most computers, the adapter-to-computer cable is a standard DB-25 M-F cable, PN 023-5800-017, (the male connector plugs into the adapter). If your computer requires a male connector, a male-to-male cable is also available, PN 023-5800-016. The cable from the adapter to the repeater has a DB-9 to 8-pin connector (see Figure 4-30).

3.1.4 EEPROM DATA STORAGE

The data programmed into the MPC is stored by an EEPROM memory. Since this type of device is nonvolatile, data is stored indefinitely without the need for a constant power supply. A repeater can be removed from the site or even stored indefinitely without affecting programming. Since EEPROM memory is also reprogrammable, a new device is not needed if programming is changed.

3.1.5 COMMAND LINE OPTIONS

HELP

To show all options available from the command line type: /h or /?. Either '/' or '-' can be used. For example: 2000pgmr /h

The options can be entered in any order.
For example: 2000pgmr /d /b /c

COM PORT

The Johnson programming software defaults to serial port COM1. However, if this port is already in use, the software can be reconfigured to use serial port COM2. To do this, use one of the following methods:

- When running the compiled (.EXE) version, type /c2 on the command line after the program name. For example: 2000pgmr /c2 or -c2
- Select COM port from Utilities heading.

BAUD RATE

The software defaults to 9600 baud, however this rate can be changed. To do this from the command line, type /bxxxx (xxxx = baud rate).
For example: 2000pgmr /b or -b

NOTE: When the baud rate is changed on the command line the baud rate jumpers on J3 in the MPC must also be changed to the same baud rate (see Section 6.11.8).

DEMO MODE

To view the screens for Read Setup Parms and Write Setup Parms from the Transfer menu when a repeater is not connected to the computer this option is used. Normally these screens are not available without a repeater connected. To do this from the command line, type: /d or -d.

For example: 2000pgmr /d

3.1.6 COLOR OR MONOCHROME OPERATION

The programming software utilizes color for a color monitor and video card. However, with LCD-type displays, this may make some information hard to read because the contrast is poor. To improve contrast, a monochrome mode can be selected in the display mode from Utilities heading.

3.2 REPEATER PROGRAM SOFTWARE

3.2.1 INSTALLING THE SOFTWARE

When you receive the programming software, make a backup copy and store the master in a safe place. Copy the distribution disks using DOS DISKCOPY command. For example, type:

DISKCOPY A: A: (single floppy drive)
or
DISKCOPY A: B: or C: (multi-drive systems).

If you have a hard disk drive, you may want to create one or more separate directories for transceiver programming and then transfer the program disk files to those directories. To create a new directory, use the MKDIR command. For example, to create directory RADIOPRG, type:

MKDIR \RADIOPRG.

Then to make the new directory the current directory, use the CHDIR command. For example, to change to the \RADIOPRG directory, type

CHDIR \RADIOPRG.

To copy all files from a floppy disk in drive A: to this directory, type:

COPY A:*.*

If you have a single floppy drive and no hard disk drive, you need to create programming disks. The reason for this is that there is not adequate space on the backup disk(s) for storing radio files. If your computer has dual floppy disk drives, the backup disk can be placed in one drive and then the radio files stored on a disk in the second drive.

To make a programming disk, format a blank disk using FORMAT B: or FORMAT B: /S (use "/S" if it must be a bootable disk). Then copy the required program file or files to the programming disk. To do this, type COPY A:(filename.ext) B:(filename.ext). For example, to copy the file 2000pgm2.exe from drive A to drive B, type

COPY A:2000pgm2.exe B:2000pgm2.exe

This procedure works for either single or dual drive computers. Refer to your computer reference manual for more information on these DOS commands.

The programming software is shipped in a compressed format. The name of the compressed file is 2000pgm2.exe and it extracts the following files so the program can be used on a PC.

2000PGMR.EXE	480K
2000PGMR.HLP	42K
TESTM8L.HLP	2K
2000PGMR.LNF	173K
TESTM8H.LNF	11K
TESTM8L.LNF	225K
TESTM9H.LNF	11K
TESTM9L.LNF	208K
TESTT8L.LNF	53K
TESTT9L.LNF	51K

The 2000PGMR2.EXE file is self extracting which means that the files extract automatically when executed. To extract these files so the program can be used, first make the current directory the destination directory for these files. For example, to make it the \RADIOPRG directory on drive C: (if not the current directory), type C: (Return) and then CD \RADIOPRG as just described. To make it the disk in drive B:, simply type B:. Then inset the program disk in drive A: and type A:2000PGM2 (or B: 2000PRM2 if drive B: is being used). The program files are automatically extracted into the current directory or disk.

3.2.2 MINIMUM FREE MEMORY REQUIRED

Approximately 525K of free conventional memory is required to run this program (use the CHKSK or MEM command to display the amount of free memory). If you have at least 640K of memory and not enough is available, there may be other programs that are also being loaded into conventional memory. Contact Customer Service for information on how these programs can be moved or disabled to make more space available.

3.3 REPEATER PROGRAMMER

When the program is loaded into the computer and executed, the menu shows the files available from the directory. The program is used to create, edit, transfer and receive the repeater and channel parameters described in Section 5.

I M P O R T A N T

The commands and displays referred to in this manual are for the IBM PC and may differ from IBM compatible. Refer to the computer's operating system manual for command explanations.

3.3.1 PROGRAM FILES

The files that appear in the program directory are needed for program operation.

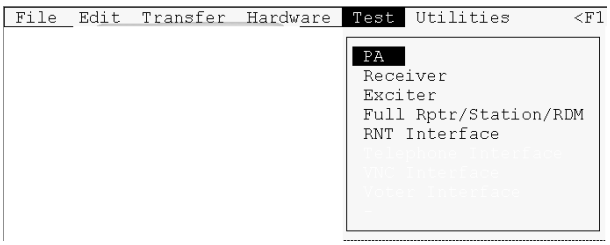


Figure 3-1 REPEATER TEST MENU

3.4 ALIGNMENT SOFTWARE

The software for the Summit QX repeater programs the MPC to open and close the audio/data gates necessary for the alignment selected from the Test-Full Repeater menu. Under the menu heading Test are the alignment procedures for the PA (see Section 7.3), Receiver (see Section 7.1), Exciter (see Section 7.2) and overall Full Repeater (see Section 7.5) including the MAC card (see Figure 3-1).

Refer to Section 7 for alignment procedures as shown in the program, alignment points diagrams and test setup diagrams.

3.5 HELP F1

Help screens are available for most parameters and options in this program. Whenever a parameter or options clarification is needed, press F1 and if a help screen is available it will pop-up on the screen. Press Escape <ESC> to exit the pop-up screen.

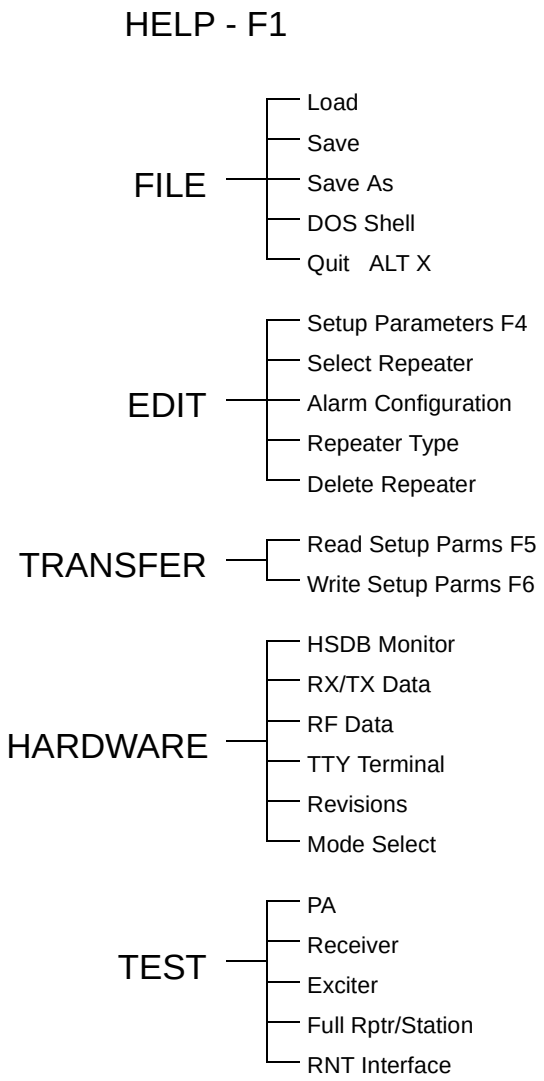


Figure 3-2 PROGRAMMING FLOWCHART

SECTION 4 PULL DOWN MENUS

4.1 MENU DISPLAYS

The menus available are listed at the top of the screen. Move the cursor with the arrow keys to highlight the menu name. Press Enter to view the menu and the arrow keys to scroll through the menu. Call up the highlighted selection by pressing Enter.

4.2 FILE MENU

This menu manipulates new or existing files into directories and saves files to be called up at another time.

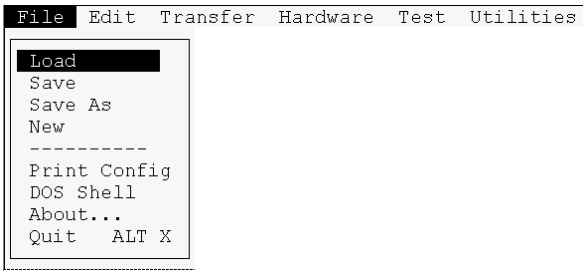


Figure 4-1 FILE MENU

4.2.1 LOAD

Load reads information from a stored file. The program requests the filename to be loaded into the buffer. The filename from a disk can be entered in the highlighted area. Then move the cursor down with the arrow key and highlight "Ok" and press Enter. To select an existing file, use the arrow keys to move down the menu list and press Enter when the highlighted filename is the file to load.

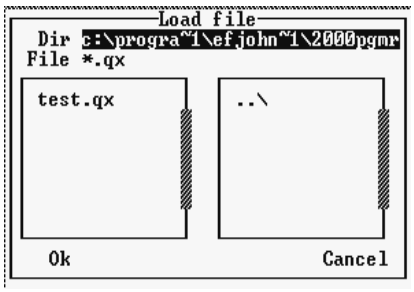


Figure 4-2 LOAD FILE

4.2.2 SAVE

This saves the edited version of an existing file loaded in the buffer under the same filename in the directory and deletes the old file. It loads a new file created in the Edit menu into the directory.

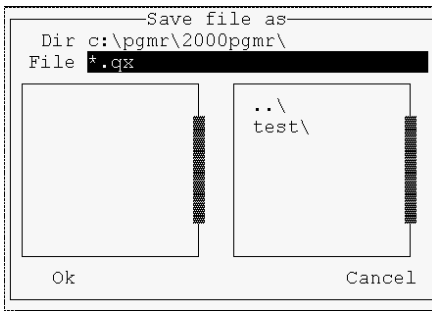


Figure 4-3 SAVE FILE

4.2.3 SAVE AS

Use Save As to edited a version of an existing file loaded in the buffer under a new filename or gives a new file created in the Edit menu a filename.

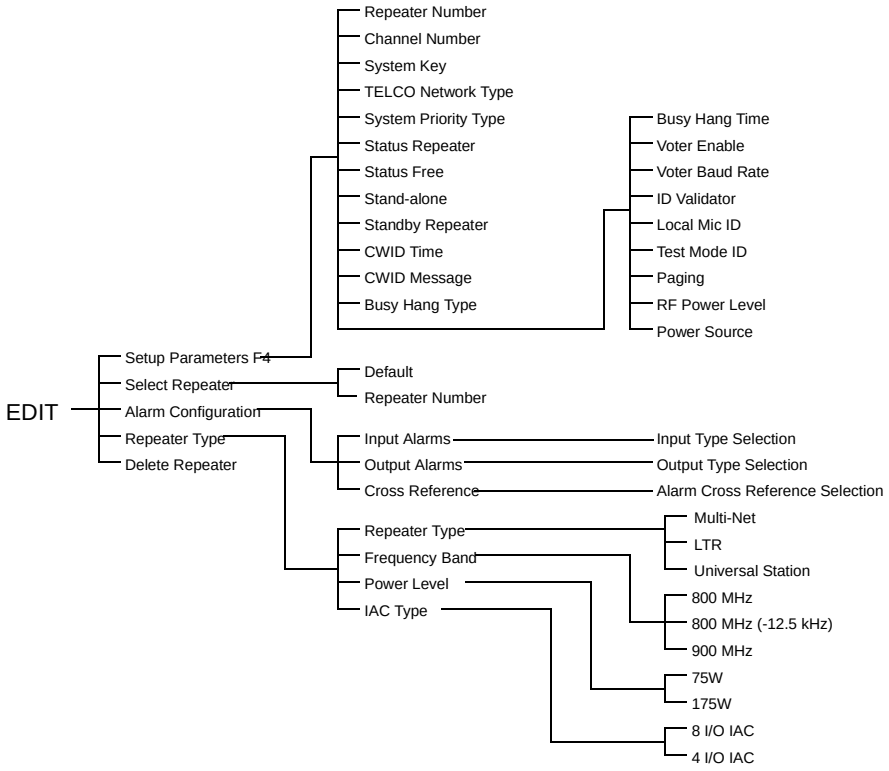


Figure 4-4 EDIT PROGRAMMING FLOWCHART

4.2.4 PRINT REPEATER CONFIGURATION

Select the destination for the configurations.
Printer - Prints to printer connected to PC.
File - Writes printable text to selected filename.

Select which repeater data will be printed.

- All Repeaters
  Prints the data for all valid repeaters.

- Single Repeater
  Print the data for the entered repeater number.

NOTE: A list of valid repeaters can be seen under the Edit-Select Repeater menu selection.

4.2.5 DOS SHELL

Temporarily suspends the program and returns to DOS. Directories and other DOS commands can be performed. To return to the program from DOS, type EXIT and press Enter.

4.2.6 QUIT (ALT X)

Exits the repeater program and returns to DOS. Be sure all files are saved before exiting the program.

4.3 EDIT

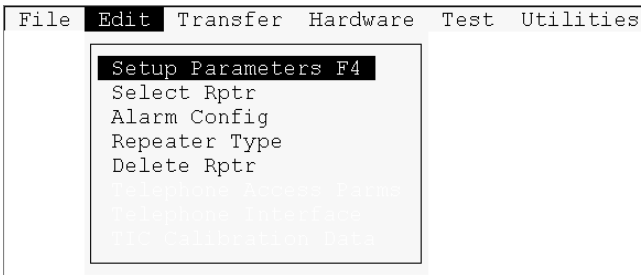


Figure 4-5 EDIT MENU

This menu is used to create new files and set or change the repeater operating parameters. The file-name for the repeaters in this file is shown in the lower left corner of the screen.

4.3.1 SETUP PARAMETERS

This programs the repeater parameters and options of each repeater at a site. Table 5-1 lists the parameters that are set by this screen (see Figure 5-1) and gives a brief description of each.

NOTE: The parameters are shown in the lower left of the pop-up screen for reference.

- Repeater Number

Each repeater is programmed with a repeater number from 1-30. Number selection can be arbitrary as long as each repeater is assigned a different number. However, make sure that this number agrees with the Home repeater number programmed in the mobiles and with the repeater number assigned to the CIM in the Switch.

- Channel Number

Each repeater is programmed with a number of the channel that it is operating on (1-920). If the operating frequency of a repeater is changed, this channel number must also be changed.

NOTE: Repeater program channel numbers 1-599 increment in 25 kHz steps. Program channel numbers 600-920 increment in 12.5 kHz steps. See Appendix A to determine the correct operating frequency.

- System Key

The system repeaters and all mobiles are programmed with a unique system key. The system key ensures that only authorized users can access a Multi-Net system. The repeater system key is programmed at the factory, and the mobile system key is programmed into the transceiver by the system operator. The system key is a number, used by both the repeaters and the mobiles, to encode the data stream. Unless both are programmed with the proper key, communication is not possible. The system key is provided to the system operator by the E.F. Johnson Company.

- Telco Network Type

CIM to repeater data signaling can be either FSK, RS-232, or FSK blank and burst.

- System Priority Type

Each repeater determines the current system priority on its channel. The current priority is then transmitted to its mobiles with other control information. The system priority received from the Home repeater and the access priority programmed into each mobile determines if a mobile can access the system at that time.

None

No priority is when all mobiles have equal preference in accessing the system because priority 5 is always transmitted by the repeater.

Next Channel

This priority comes on line only when all channels in the system are busy. A timed sequence of access priority is stepped through when a channel does become available. Priority 1 mobiles are given immediate access, and then 0.5 second later, priority 2 mobiles are given access, and so on until 2 seconds later when priority 5 mobiles are given access. A mobile programmed with a priority number equal to or greater than the current priority status can always immediately access the system. If a second channel becomes available during the countdown sequence, all mobiles have immediate access.

Reserved Channel

The last available channel is reserved for exclusive use by Priority 1 mobiles. Therefore, when only one repeater is free, a system priority number of "1" is transmitted by the repeater.

Both Reserved And Next Channel

This is a combination of the Next Channel and Reserved Channel priority schemes. When only one repeater is free, it is reserved for exclusive use by Priority 1 mobiles. When two channels are free, immediate access is given to both Priority 1 and 2 mobiles. Then, if two repeaters remain free for 0.5 second, the stepped access begins. Priority 3 mobiles are given first access, followed by Priority 4 mobiles at the 1-second point, and Priority 5 mobiles at the 1.5-second point. If during this time, only one repeater is again free, stepped access halts and only Priority 1 mobiles have access. However, if a third repeater becomes available, all mobiles have immediate access.

- Status Repeater

One repeater at a site is normally designated as a Status repeater. Besides handling calls normally, this repeater transmits call information for all other calls occurring at the site. This allows it to act as a backup for the other repeaters. Normally, no mobiles are assigned to this repeater as a Home repeater because they would not have a backup repeater. The repeater is available for voice traffic.

- Status Free

IMPORTANT

This option must be programmed to the same state in all repeaters in the same site.

This option affects the availability of the Status Repeater for use as a voice channel.

NOTE: The "Status Free" parameter has no effect on Sites with 5 or more repeaters and repeater operation is identical to Status Free parameter "No".

Sites with less than 5 repeaters, Parameter "No"

The Status Repeater gets FREE consideration only if a local repeater detects the Status Repeater as the only Idle repeater in the HSDB frame immediately preceding the local repeater's HSDB transmit window.

Sites with less than 5 repeaters, Parameter "Yes"

The Status Repeater is available for FREE consideration with the same probability as all other repeaters on the HSDB.

- Stand Alone

Multi-Net repeaters are intended to be connected to a Switch or CIMs. The Stand Alone option determines what the repeater is to do when the link to CIM is lost.

YES allows the repeater to remain on the HSDB and continue to handle requests for service normally.

NO causes the repeater to remove itself from the HSDB and to no longer handle requests or disable itself.

- Standby Repeater

Systems can be set up with standby repeaters that take over operation if main repeaters become inoperative. A standby repeater is set up on the same channel with the same operating parameters as the repeater it is backing up. A standby repeater is not the same as a Status repeater.

- CWID Time

This is the time interval between transmission of the repeater's CWID message (Disable, 1-60 min).

- CWID Message

FCC regulations require that the station call letters be transmitted periodically on the lowest- frequency repeater in the system and disabled on all the others. Morse code is used to encode these letters/numbers for continuous-wave (CW) transmission (15 characters/numbers UPPER CASE).

- Busy Hang Type

This determines if the hang time programmed is to be used on all the calls (Full Hang) or if hang time only occurs under Busy System conditions (Conditional Hang).

- Busy Hang Time

This is the delay time before the repeater stops transmitting after a call is completed (0-5 sec).

- Voter Enable

In the voter mode, the logic accepts and processes data from the voter. In the non-voter mode, data from the receiver is processed.

- Voter Baud Rate

Voter baud rate is the selectable data rates for voter data, 2400 or 9600 baud.

- ID Validator

Not applicable at this time.

- Local Mic ID

The local microphone connected to the MAC jack is assigned a Group ID for transmitting when the local microphone PTT is active. This Group ID can be set from 1-225, 0 = disabled, the default for Test Mode is 253. This allows the repeater to operate as a base station, with or without an Switch.

- Test Mode ID

This is the Group ID that is transmitted when the repeater is in the Test Mode. Mobiles with the same Group ID can communicate with the repeater in the Test Mode. The Group IDs are from 1-225, 0 = disabled, the default for Test Mode is 253.

- Paging

This indicates if there is an optional paging terminal connected to the repeater.

- RF Power Level

This is the default power level. Enter the power level (25-75 Watts) that the repeater will use for transmit power.
NOTE: Not the actual power out level. Other factors must be considered for a true power out.

- Power Source

This indicates the primary power source for the repeater (AC/DC). If AC is selected and Battery Backup is installed, the transmitter goes to half rated power (max.) when AC fails. If DC is selected and AC fails, power output is unchanged.

- Simulcast Option

Select "No" for regular Multi-Net installations. The special High Stability Synthesizer circuitry is absent.

4.3.2 SELECT REPEATER

Select the repeater number to be programmed or edited from the pop-up menu (see Figure 4-6). Move the cursor with the arrow keys to highlight the repeater number and press Enter.

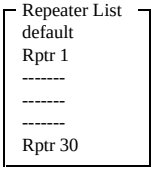


Figure 4-6 REPEATER LIST

4.3.3 ALARM CONFIGURATION

This programs the input alarm (see Figure 4-8) and output alarm (see Figure 4-9) configurations and provides a cross reference screen.

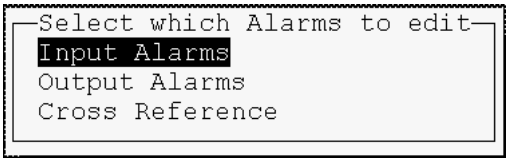


Figure 4-7 ALARM CONFIGURATION

Use the arrow keys to move down the list. Use the Space bar to toggle through the parameters: Disabled, Active Low, Active High, for each alarm.

INPUT ALARMS

There are four or eight input alarms that can be activated by external devices (see Section 6.13). These inputs can be disabled, energized or de-energized.

If the input is disabled, the input alarm line is inactive. When energized and current flow is detected, the alarm is activated. When de-energized and no current flow is detected, the alarm is activated.

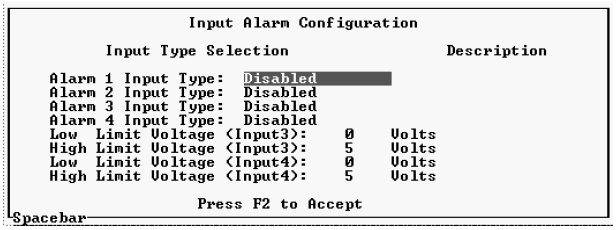


Figure 4-8 INPUT ALARMS

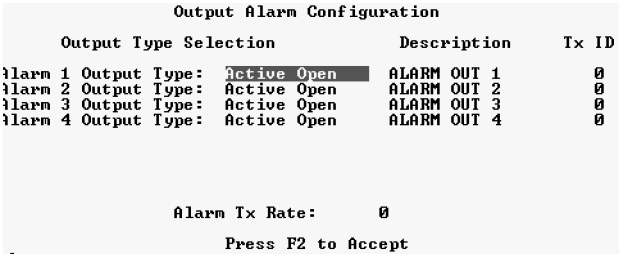


Figure 4-9 OUTPUT ALARMS

- Output Type Selection

Select the operation of the Output Alarm. The available types are:

Active Open - An active alarm opens (no contact) the output lines.
Active Closed - An active alarm closes (contact) the output lines.

- Alarm Description

This is a text string (up to 15 characters) to describe the alarm. This test string is sent via Morse code if the alarm input is programmed with a Tx ID and an output is selected in the cross reference menu (see Figure 4-10).

- Transmit ID

Each of the 8-alarm outputs can be assigned a Group ID from 1-225 (default setting is 0 (zero) for disabled). This Group ID and the repeater number identify an active alarm. This ID is programmed into a transceiver so that when the alarm is active, the alarm description is received in Morse code.

- Alarm Transmit Rate

Sets the time interval for transmitting the alarm message (1-255 min, 0=disabled). If more than one alarm is active, this is the inter-alarm time.

- Cross Reference

The cross reference screen selects the output alarm that is activated by each input alarm. There are up to 48 alarms (0-47), 8 external input alarms and 40 internal alarms (see Table 1-2). There are eight output alarms. An alarm condition on any input can cause an output alarm. This screen configures which input alarm activates an output alarm.

NOTE: More than one alarm condition can have the same output alarm (see Figure 4-10).

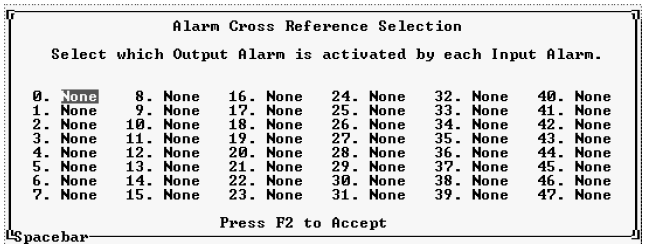


Figure 4-10 ALARM CROSS REFERENCE

4.3.4 REPEATER TYPE SELECTION

This screen (see Figure 4-11) selects the repeater type (Multi-Net signaling protocol and features),

Frequency Band	800 MHz
	800 MHz (-12.5 kHz)
	900 MHz)
Power Level	75W
	175W

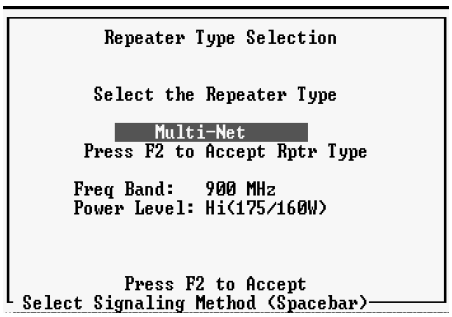


Figure 4-11 REPEATER TYPE SELECTION

4.3.5 DELETE REPEATER

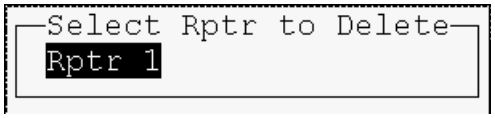


Figure 4-12 DELETE REPEATER

4.4 TRANSFER

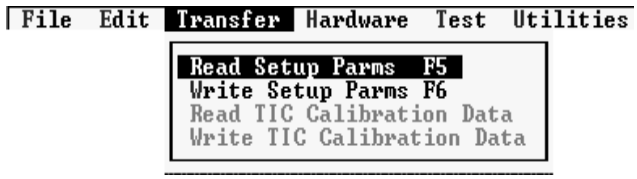


Figure 4-13 TRANSFER MENU

4.4.1 WRITE SETUP PARAMETERS

This command sends the contents of a file to the repeater and programs the EEPROM memory in the Main Processor Card (MPC).

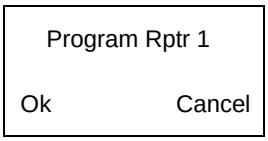


Figure 4-14 WRITE SETUP PARAMETERS

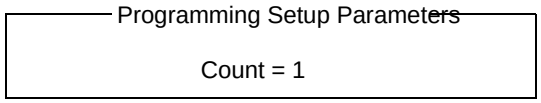


Figure 4-15 PROGRAM WRITE SETUP

4.4.2 READ SETUP PARAMETERS

This command reads the contents of the EEPROM memory of a repeater and loads it into a buffer. The contents of the buffer is then displayed to show the programming of the repeater.

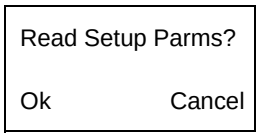


Figure 4-16 READ SETUP PARAMETERS

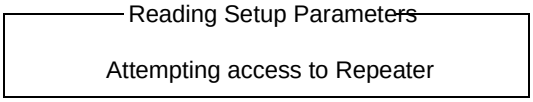


Figure 4-17 READING SETUP

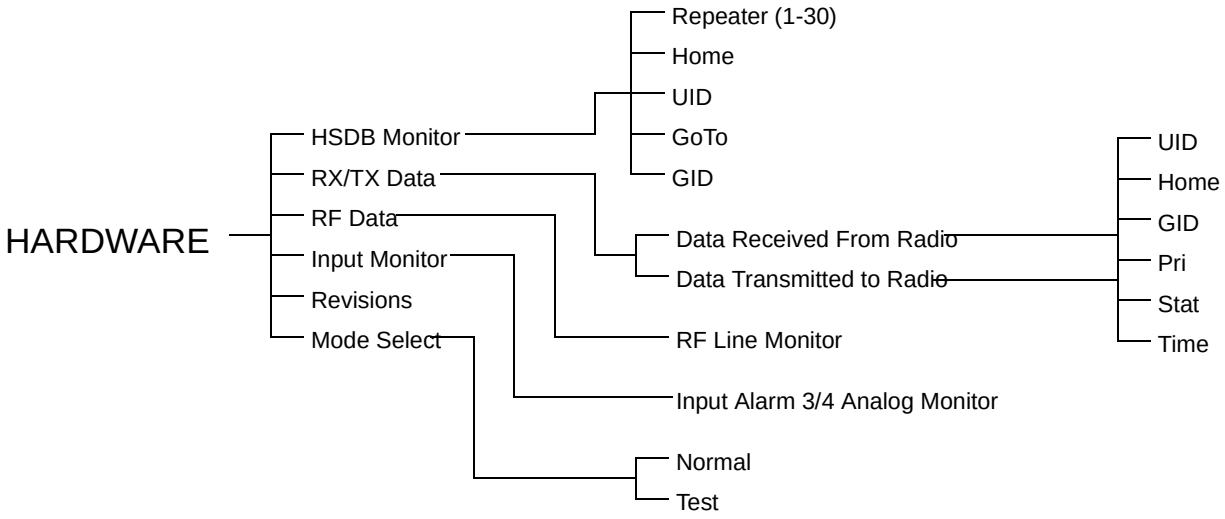


Figure 4-18 HARDWARE PROGRAMMING FLOWCHART

4.5 HARDWARE

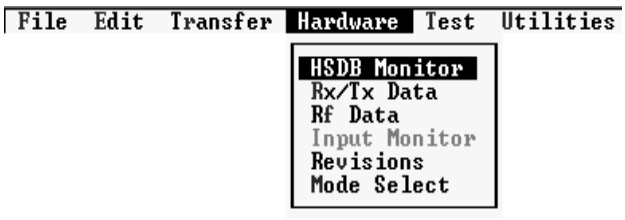


Figure 4-19 HARDWARE MENU

4.5.1 HSDB MONITOR

High Speed Data Bus (HSDB) connects all repeaters at a site and continually sends updates on the status of each repeater. This information screen provides a list of all repeaters at the site (1 to 30). If a repeater is not sending data, IDLE is next to the repeater number. The data sent by the repeater is used to determine the Home, GID and UID of destination (i.e. mobile or Switch) users to receive the call placed by the originator.

The Home column refers to the Home repeater number of the originator, therefore the Repeater number and the Home number may not be the same number. The UID is the Unique ID used to identify the originator of special calls. The GID column refers to the Group ID of the talk group of the originator. The GoTo column shows the repeater channel all destination users switch to so they receive the call.

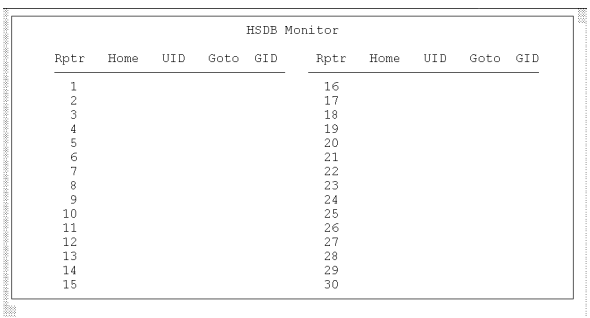


Figure 4-20 HSDB MONITOR

4.5.2 RECEIVE/TRANSMIT DATA

This is an information screen used at the repeater site while the computer (laptop) is connected to the MPC in the repeater being monitored. This information is contained in the data message exchanged between the repeater and the destination user (mobile or Switch).

The message contains data received from the destination and data sent to the mobile by the repeater. The repeater receives the destination's: Unique ID, Home repeater Number, Group ID, Priority, Status and Time Stamp. This same information is sent to the destination in the update message from the repeater. The time stamp is included because messages are sent continually and this provides a reference for when a data exchange took place.

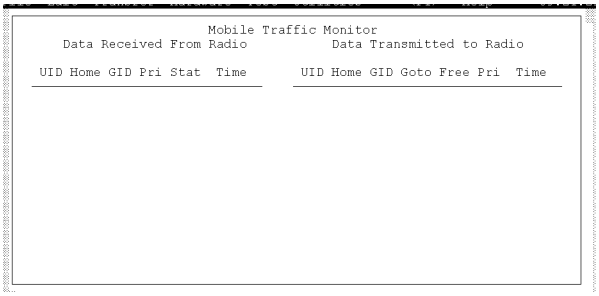


Figure 4-21 MOBILE TRAFFIC MONITOR

4.5.3 RF DATA

The A/D Monitor Screen shows the state of the lines (see Figure 4-22). These lines are being monitored by the A to D converter in the IAC. The normal values for each line are defined as follows.

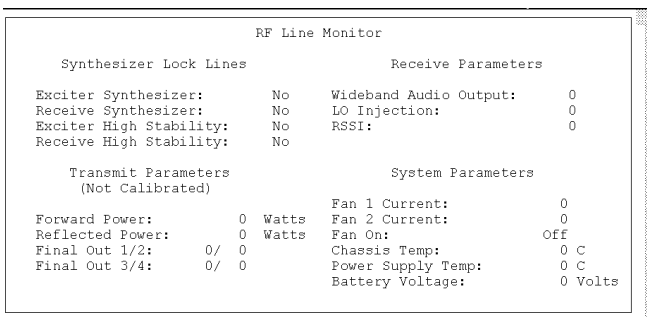


Figure 4-22 RF LINE MONITOR

Synthesizer Lock Lines	Yes or No
Forward Power (LP)	25-75 Watts
Forward Power (HP)	75-175 Watts
Reflected Power	0-6 Watts
Final Out	approx equal
Chassis Temp	27°C-55°C
Wideband Audio Output	approx 200
LO Injection	approx 200
RSSI	20-150
Fan Current	100-200, 0
Fan	On or Off
Power Supply Temp	22°C-45°C
Battery Voltage	21V-28V

Values with no label are the actual A to D reading. To calculate the voltage on the line, divide the value by 51. Example: Value ÷ 51 = Volts. Any variation from the above values may indicate a problem in that area.

4.5.4 INPUT MONITOR

The Input Monitor is displayed for analog input alarms. The screen shows the actual voltage of the input and the high/low limits. The description of the alarm entered in the Edit -> Alarm Configuration -> Input Alarms menu as well as the Input Type (Energized, De-Energized or Analog).

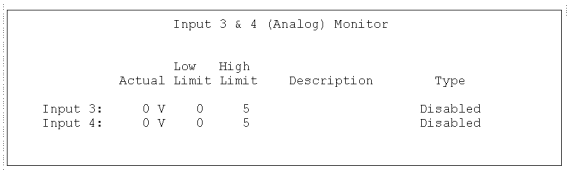


Figure 4-23 INPUT MONITOR

4.5.5 REVISION/VERSION

The Revision/Version is displayed for the repeater modules. The format is R.V (revision.version) for all modules. The MPC information also includes the release date of the software and the serial number of the repeater (see Figure 4-24).

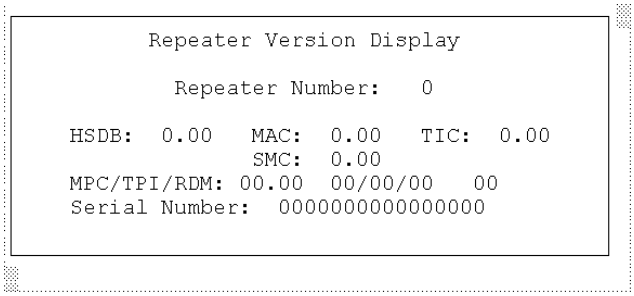


Figure 4-24 REVISION/VERSION

4.5.6 MODE SELECT

The Mode Select screen places the repeater either in the normal mode or the test mode. In the 'Normal mode' the repeater operates as a normal repeater.

In the 'Test mode' the repeater transmits a test word. This test word is the Test Mode ID setup in the Setup Parameters (see Section 4.3.1). While in the test mode the repeater is "busy", therefore it is important to place the repeater in 'Normal mode' when the test mode is no longer required.

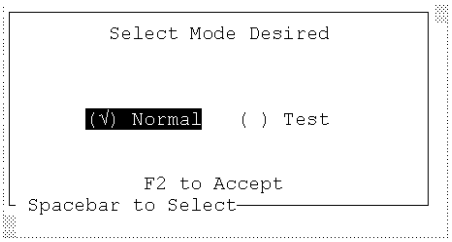


Figure 4-25 MODE SELECT

4.6 TEST

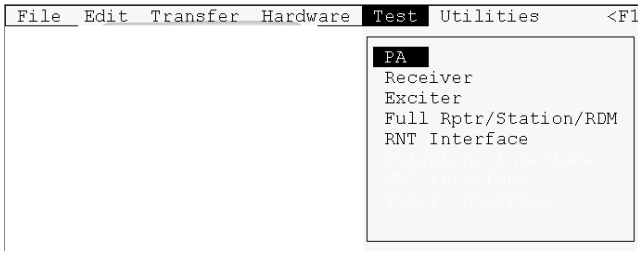


Figure 4-26 TEST MENU

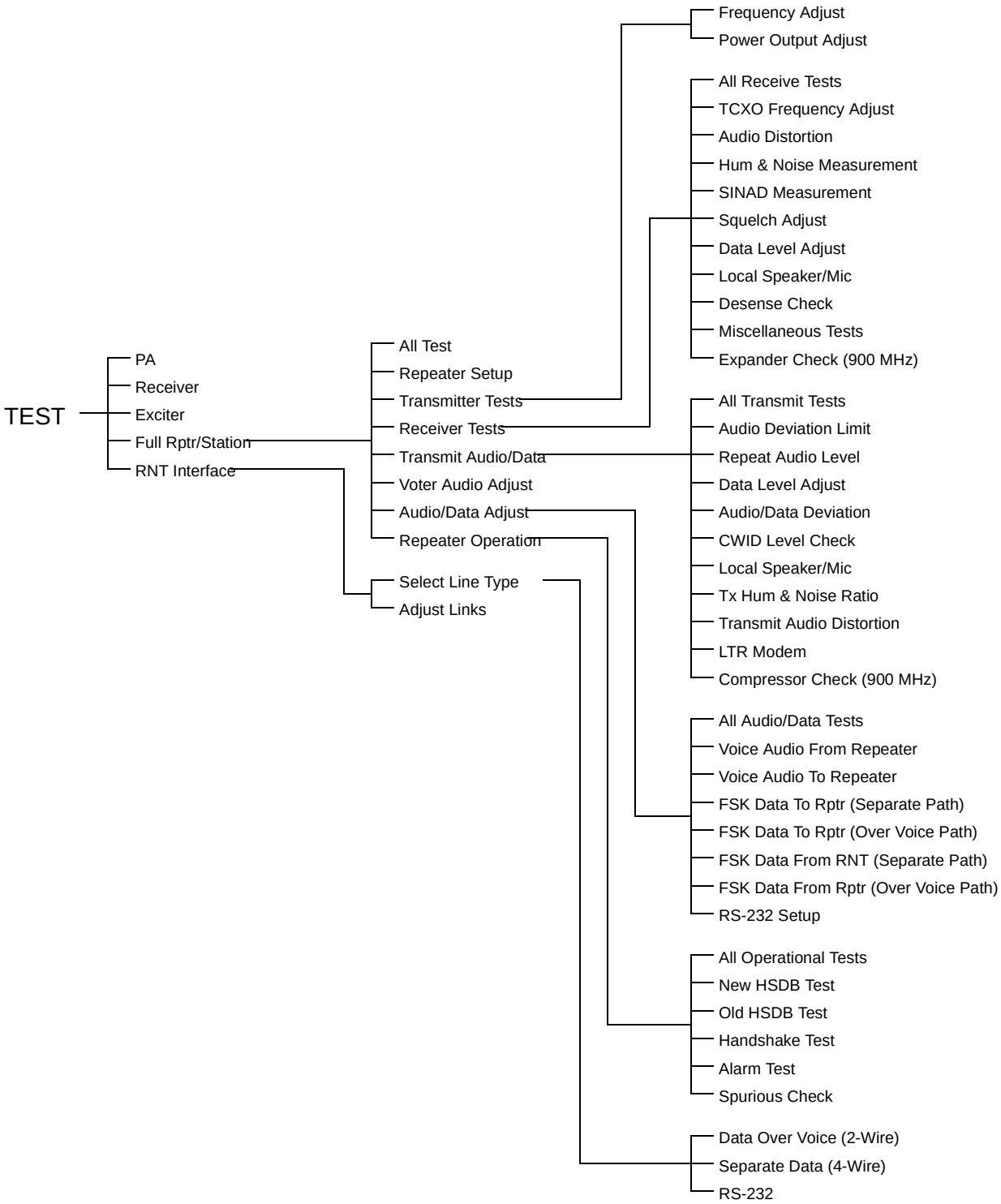


Figure 4-27 TEST PROGRAMMING FLOWCHART

4.6.1 POWER AMPLIFIER

This menu selection walks through the alignment of the PA and RF Interface Board on the computer screen. Refer to Section 7.3 or 7.4 for the PA and RFIB alignment in this manual and Figures 7-3 and 7-5 for an alignment points diagram and Figure 7-9 of the PA.

4.6.2 RECEIVER

This menu selection walks through the alignment of the receiver on the computer screen. Refer to Section 7.1 for the receiver alignment in this manual and Figure 7-1 for an alignment points diagram and Figure 7-6 of the receiver.

4.6.3 EXCITER

This menu selection walks through the alignment of the exciter on the computer screen. Refer to Section 7.2 for the exciter alignment and Figure 7-2 for an alignment points diagram and Figure 7-7 for a test setup of the exciter.

4.6.4 FULL REPEATER

This menu selection walks through the alignment of the entire repeater. The receiver and Exciter portions are performance tests and adjustments. The audio and data portions are level adjustments for the Main Audio Card (MAC). Refer to Figure 7-20 for an alignment points diagram for the MAC.

4.6.5 SWITCH INTERFACE

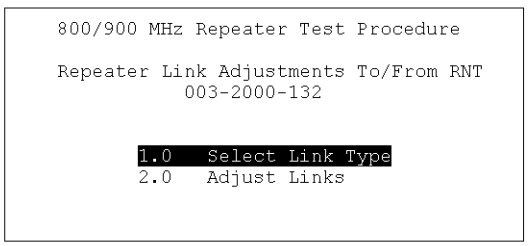


Figure 4-28 SWITCH INTERFACE

This menu selection walks through the alignment of the connection between the repeater and the associated CIM in the Switch. The alignment includes three types of lines; Voice Over Data (2-Wire), Separate Data (4-Wire) and RS-232. Refer to Section 7.6 for alignment procedure.

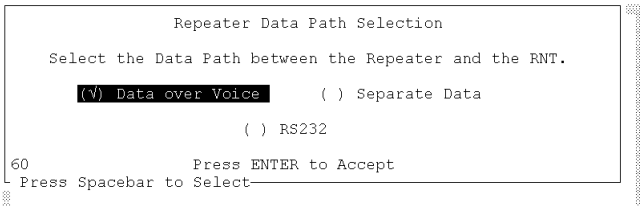


Figure 4-29 DATA PATH SELECTION

4.7 UTILITIES

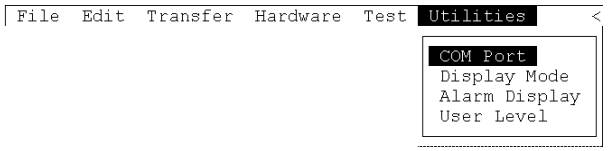


Figure 4-30 UTILITIES MENU

4.7.1 COM PORT

This is the COM port used to send and receive data from the repeater MPC. An interface cable connects the repeater to the computer (see Figure 4-32).

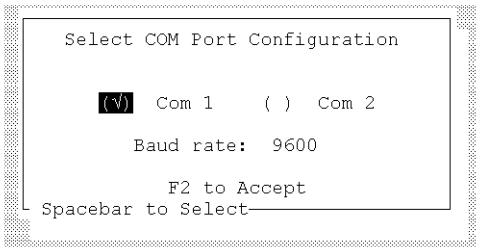


Figure 4-31 COM PORT SELECTION

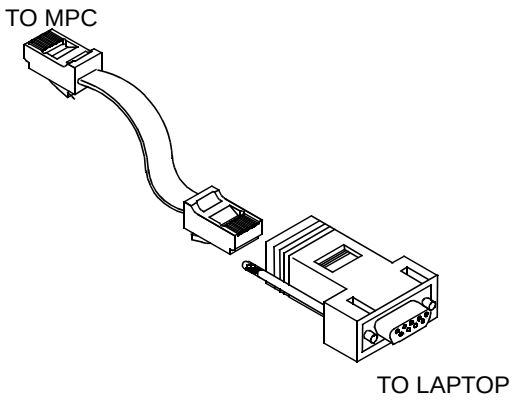


Figure 4-32 LAPTOP INTERCONNECT

4.7.2 DISPLAY MODE

This screen allows the color mode to be selected for color monitors. When using a laptop, monochrome is recommended for better resolution.

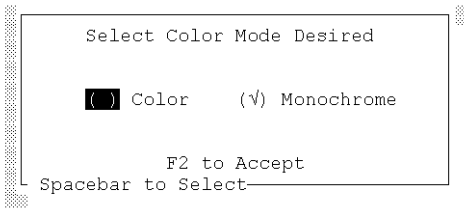


Figure 4-33 COLOR MODE SELECTION

4.7.3 ALARM DISPLAY

This screen displays a scrolling list of alarms generated by the repeater.

4.7.4 USER LEVEL

There are two levels to choose from, 'Novice' and 'Advanced'. The novice uses prompts in the Edit-Parameters screens when Escape or F2 keys are pressed that ask "are you sure" before the task is executed. The advanced selection performs the task without asking the question.

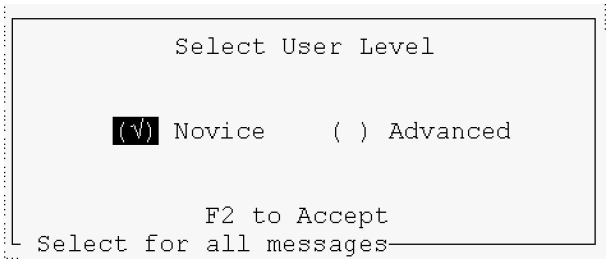


Figure 4-34 USER LEVEL

SECTION 5 REPEATER PROGRAMMING

5.1 CREATING A NEW FILE

An example will be used to show the programming for a new file created for Site 1.

NOTE: At any point in the programming sequence, if F1 is selected, a help screen appears to explain the menu selection highlighted at that point.

5.1.1 SELECT REPEATER TO EDIT

A repeater is selected to program. When no file exists with programmed repeaters, the default is selected and edited.

1. Highlight EDIT, press Enter.
2. Highlight SELECT REPEATER, press Enter.
3. Default is the only repeater in this list, press Enter.
4. Highlight EDIT, press Enter.
5. Highlight SETUP PARAMETERS, press Enter.
6. The Setup Parameters screen appears (see Figure 5-1). Fill in the parameters for this repeater. A brief description of the parameters is in Table 5-1. Full descriptions are in Section 4.3.1.
7. Select parameters, press F2 to accept.
8. Highlight EDIT, press Enter.
9. Highlight ALARM CONFIGURATION and press Enter, if alarms are to be configured.
10. Program the Alarms to be configured (see Section 4.3.3), press F2 to accept.
11. Highlight FILES, press Enter.
12. Highlight SAVE, press Enter.
13. Type in a valid DOS filename. For this example site1.dat is used.
14. The file consists of default and repeater one under the filename of site1.dat.

5.2 ADDING A REPEATER TO A FILE

The example used for Site 1 will again be used to add repeaters to the filename site1.dat.

1. Highlight EDIT, press Enter.
2. Highlight SELECT REPEATER, press Enter.
3. The repeater list shown for this file includes default and repeater one. These contain the same parameters with the exception that when selected for edit the programmed repeater can be overwritten and the data lost.
4. Highlight DEFAULT, press Enter.
5. Highlight EDIT, press Enter.
6. Highlight SETUP PARAMETERS, press Enter.
7. Change the repeater number and other parameters as required for this repeater, press F2.
8. Highlight EDIT, press Enter.
9. Highlight ALARM CONFIGURATION and press Enter, if alarms are to be configured.
10. Program the Alarms to be configured (see Section 4.3.3), press F2 to accept.
11. Highlight FILES, press Enter.
12. Highlight SAVE, press Enter.
13. Repeater 2 is added to the 'Repeater List' in file site1.dat.

Table 5-1 REPEATER SETUP PARAMETERS

Parameter	Response	Description
Repeater Number	1-30	Each repeater is assigned a number from 1-30.
Channel Number	1-399	Each repeater is programmed with a number of the channel that it is operating on.
System Key	0-65535	Assigned by E.F. Johnson Company.
Telco Network Type	Sec Dig B&B None	Data signaling type from the CIM to the repeater. FSK = AFSK secondary lines RS-232 = Digital secondary lines FSK Blank & Burst = AFSK primary lines None = Dispatch (no Switch)
System Priority Type	0=None 1=Rsv'd Chan 2=Next Chan 3=Both Rsv'd & Next	Each repeater determines the current system priority on its channel.
Status Repeater	Yes, No	One repeater at a site is a status repeater. It is usually the last repeater assigned for voice.
Status Free	Yes, No	*This parameter has no effect on Sites with more than 5 repeaters and repeater operation is identical to a 'No' response.* **No:** Site with less than 5 repeaters. The Status Repeater gets 'Free' consideration only if a Local repeater detects the Status Repeater as the only Idle repeater in the HSDB frame immediately preceding that Local repeater's HSDB transmit window. **Yes:** Site with less than 5 repeaters. The Status Repeater is available for 'Free' consideration with the same probability as all other repeaters on the HSDB.
Stand Alone	Yes, No	If the CIM link is lost; Yes allows the repeater to continue to operate normally. No disables the repeater.
Standby Repeater	Yes, No	Repeater enabled by Switch to take over if main repeaters become inoperative.
CWID Time	0=disable, 1-60 min	Time between CWID transmissions.
CWID Message	15 characters/numbers	Station call letters all in UPPER CASE.
Busy Hang Type	0=Conditional Hang 1=Full Hang	Determines which type of Hang.
Busy Hang Time	0-5 sec	Delay time before the repeater stops transmitting.
Voter Enable	Yes, No	Enabled if repeater is used in a voter system. The internal receiver is not used.
Voter Baud Rate	2400, 9600	The baud rate of the voter data.
ID Validator	Yes, No	Not applicable at this time.
Local MIC ID	0 = transmits carrier 1-225, 253	Group ID transmitted when the local microphone PTT is active.
Test Mode ID	0 = transmits carrier 1-225, 253 = default	Group ID transmitted when the repeater is in the test mode.
RF Power Level	25-75 / 75-160	Power level in watts for transmit power.
Power Source	AC, DC	The type of primary power source for the repeater.
Paging	Yes, No	Select if a paging terminal is installed.
Simulcast Option	Yes, No	Select No for regular Multi-Net installations.
NOTE: For full descriptions of all parameters refer to Section 4.		

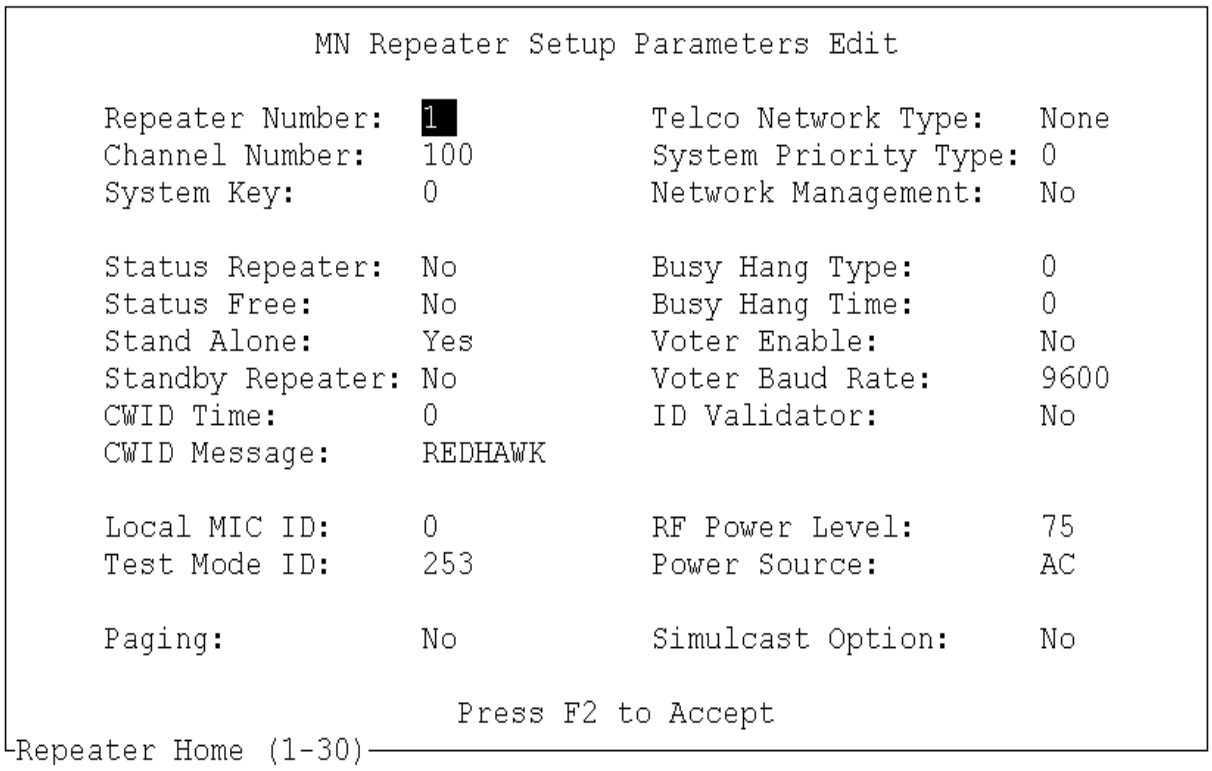


Figure 5-1 SETUP PARAMETERS

SECTION 6 CIRCUIT DESCRIPTION

6.1 RECEIVER

6.1.1 INTRODUCTION

The receiver is a double conversion type with intermediate frequencies of 52.95 MHz and 450 kHz. The first injection frequency is phase locked to a temperature compensated crystal oscillator (TCXO) with a frequency stability of ±1.0 PPM from -30° to +60° C (-22° to +140° F). Two 3-pole bandpass filters in the front-end reject signals outside the receive band. Two 4-pole crystal filters and one 6-pole ceramic filter establish receiver selectivity (see block diagram Figure 6-1).

6.1.2 REGULATED VOLTAGE SUPPLIES

The +15V DC power source is supplied by the repeater power supply. The +15V supply enters the receiver on J201, pin 1. U206 provides the +12V DC receive voltage to the RF and IF amplifiers. U210 supplies +12V DC to the first injection amplifiers. U207 supplies +12V DC to the remaining +12V DC circuits. U208 supplies +6V DC to the remaining circuits.

6.1.3 HELICAL FILTER, RF AMPLIFIER

The receive signal enters the receiver on coaxial connector A201. A helical filter consisting of L201, L202 and L203 is a three-pole bandpass filter tuned to pass only a narrow band of frequencies (806-824 MHz) to the receiver. This filter also attenuates the image and other unwanted frequencies.

Impedance matching between the helical filter and RF amplifier Q201 is provided by C201, C202 and a section of microstrip. Q201 amplifies the receive signal to recover filter losses and increases receiver sensitivity. Biasing for Q201 is provided by R201/R203/C203 and C204 provides RF bypass. Additional filtering of the receive signal is provided by 3-pole helical filter L204-L206. A section of microstrip on the collector of Q201 and C205/C207 match the impedance from Q201 to 3-pole helical filter L204-L206.

6.1.4 FIRST MIXER, CRYSTAL FILTER

First mixer U201 mixes the receive frequency with the first injection frequency to produce the 52.95 MHz first IF. Since low-side injection is used, the injection frequency is 52.95 MHz below the receive frequency. Matching between filter L204-L206 and the mixer is provided by L228, C208 and C372. The output of U201 is matched to Z201 at 52.95 MHz by L207, C209 and C267.

Z201 and Z202 form a two-section, four-pole filter with a center frequency of 52.95 MHz and a -3 dB bandwidth of 15 kHz. This filter attenuates adjacent channels and other signals close to the receive frequency. The filter sections are a matched pair and the dots on the cases indicate which leads connect together. Matching with Q202 is provided by C210, L209 and C270.

6.1.5 IF AMPLIFIER, CRYSTAL FILTER

Q202 amplifies the 52.95 MHz IF signal to recover filter and mixer losses and improve receiver sensitivity. Biasing for Q202 is provided by R208/R209/R210/R211/R313 and C211/C212/C213 provide RF bypass. The output of Q202 is matched to crystal filter Z203 at 52.95 MHz by C214, C293 and L211.

Z203 and Z204 form a two-section, four-pole filter with a center frequency of 52.95 MHz and a -3 dB bandwidth of 15 kHz. This filter establishes the selectivity of the receiver by further filtering the 52.95 MHz IF. The filter sections are a matched pair and the dot on the case indicates which leads connect together. Matching with U202 is provided by C215, C216, C301, L225 and R322.

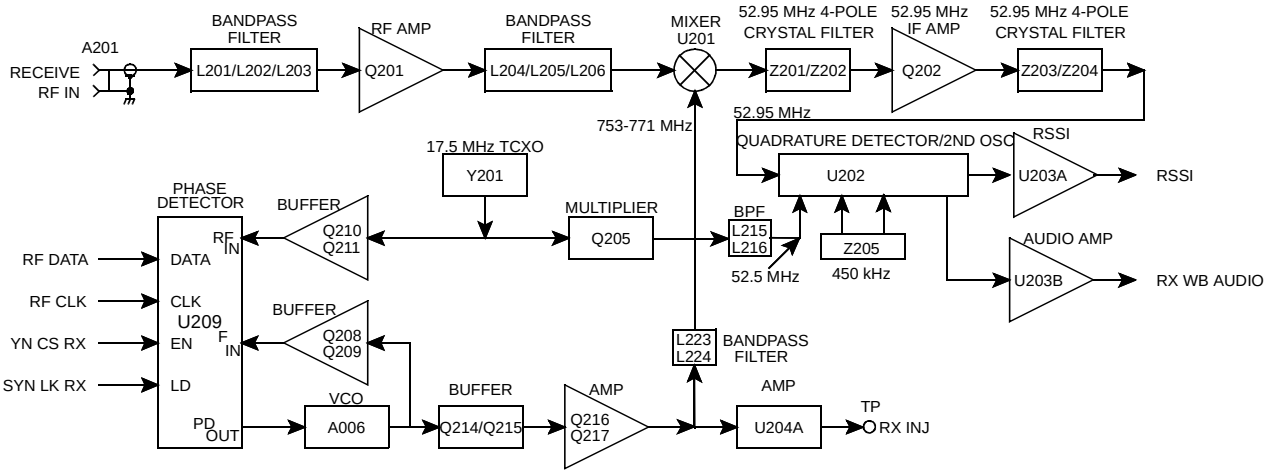


Figure 6-1 RECEIVER BLOCK DIAGRAM

6.1.6 SECOND MIXER/DETECTOR

As shown in Figure 6-2, U202 contains second oscillator, second mixer, limiter, detector and RSSI circuitry. The 52.95 MHz IF signal is mixed with a 52.5 MHz signal produced by TCXO Y201 and tripler Q205. The 17.5 MHz (±1 PPM) output of Y201 is fed through C231 to tripler Q205. The tripler passes the third harmonic at 52.5 MHz to the oscillator input of U202.

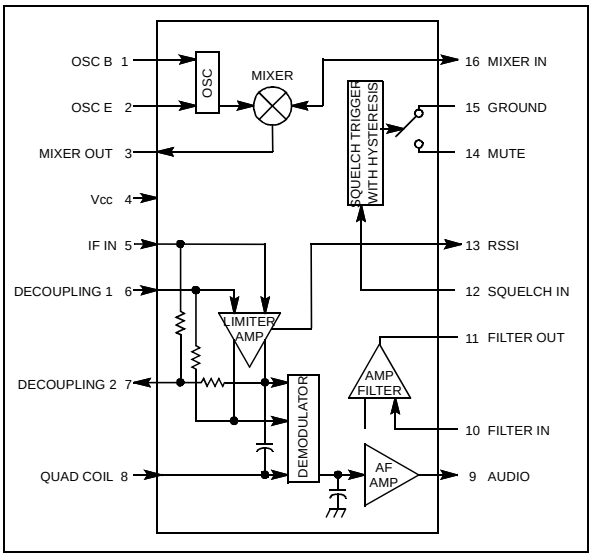


Figure 6-2 U202 BLOCK DIAGRAM

Biasing of Q205 is provided by R228, R227 and R229. RF choke L214 blocks the flow of RF through R229. An AC voltage divider formed by C236/C235 matches Q205 to the highpass filter. The third harmonic of the TCXO frequency is then used to drive the OSC B input at 52.5 MHz. L215, C237 and L216 form a high pass filter to attenuate frequencies below 52.95 MHz. C222 and C238 match the output of the filter to U202.

The 450 kHz second IF is then fed to ceramic filter Z205, then into the IF amplifier. The center frequency of Z205 is 450 kHz with a bandwidth of 15 kHz used to attenuate wideband noise. The limiter amplifies the 450 kHz signal 92 dB which removes any amplitude fluctuations.

From the limiter the signal is fed to the quadrature detector. An external phase-shift network connected to U202, pin 8, shifts the phase of one of the detector inputs 90° at 450 kHz (the other inputs are unshifted in phase). When modulation occurs, the frequency of the IF signal changes at an audio rate as does the phase of the shifted signal. The detector, which has no output with a 90° phase shift, converts the phase shift into an audio signal. Z213 is adjusted to provide maximum undistorted output from the detector. The audio signal is then fed out on U202, pin 9.

6.1.7 WIDEBAND AUDIO AMPLIFIER

U203B amplifies the detected audio and data signal. R280/R263 set the gain of the amplifier and R256/R262/R284 provide a DC reference level. C220 bypasses the 450 kHz IF signal and C240 bypasses other frequencies. The output signal is adjusted by R264 and fed to J201, pin 9.

6.1.8 RSSI AMPLIFIER

U202, pin 13 is an output from an internal RSSI (receive signal strength indicator) circuit which provides a current proportional to the strength of the 450 kHz IF signal. The RSSI output is buffered through U203A and the level is adjusted by R261. The DC output signal is then fed to J201, pin 7.

6.1.9 VCO

The Voltage-Controlled Oscillator (VCO) is formed by Q802 circuitry and a resonator consisting of L220 in the Receiver. The adjusting screw in L220 tunes the tank circuit to the desired frequency range. The VCO oscillates in a frequency range from 753-771 MHz. Biasing of Q802 is provided by R805, R806 and R807. AC voltage divider C812 and C813 initiates and maintains oscillation. C803 couples Q802 to L220 that provides the shunt inductance of the tank circuit. The shunt capacitance of the tank circuit is made primarily by C804 in series with CR802.

The VCO frequency is controlled in part by DC voltage across varactor diode CR802. As voltage across a reverse-biased varactor diode increases, its capacitance decreases. Therefore, VCO frequency increases as the control voltage increases. The control line is RF isolated from tank circuit by choke L804. The amount of frequency change produced by CR802 is controlled by series capacitor C804.

6.1.10 ACTIVE FILTER

Q801 functions as a capacitance multiplier to provide filtering of the 12V supply to Q802. R801 and R802 provide transistor bias, and C809 provides the capacitance that is multiplied by the gain of Q801. If a noise pulse or other voltage change appears on the collector, the base voltage does not change because of C809. Therefore, the base current does not change and transistor current remains constant. R803 decouples the VCO output from AC ground. L803 is an RF choke; and C807, C808, C810 and C811 provide RF bypassing.

6.1.11 BUFFER

A cascode amplifier formed by Q208/Q209 provides amplification and isolation between the VCO and Synthesizer. A cascode amplifier is used because it provides high gain, high isolation and consumes only a small amount of power. The input signal to this amplifier is coupled from the VCO RF output on pin 4. DC blocking and coupling to the VCO is provided by C268 and to the buffer by C261. Bias for the amplifier is provided by R275, R279, R278 and R277. Q209 is a common-emitter amplifier and Q208 is a common-base with C260 providing RF bypass. L219 provides some filtering of the cascode output. R273 lowers the Q of L219. The output of the amplifier is coupled by C309 to U209, pin 11.

6.1.12 SYNTHESIZER

The synthesizer inputs/outputs are shown in Figure 6-3. The synthesizer output signal is the receiver first injection frequency. This signal is produced by a VCO (voltage-controller oscillator). The oscillator frequency is controlled by a DC voltage, generated by integrating pulses from the phase detector in synthesizer chip U209. This integration is performed by the synthesizer loop filter which is made up of C805, C806 and R804 in the VCO circuitry.

Frequencies are selected by programming counters in U209 to divide by a certain number. This programming is provided through J201, pins 12, 18 and 20. The frequency stability of the synthesizer is established by the ±1.0 PPM stability of TCXO Y201. The oscillator output is stable from -30°C to +60°C (-22°F to +140°F).

The VCO frequency of A006 is controlled by a DC voltage produced by integrating the phase detector output pulses of U209. The phase detector senses the phase and frequency of the two input signals (f_V and f_R) and causes the VCO control voltage to increase or decrease if they are not the same. When the frequencies are the same the VCO is "locked" on frequency.

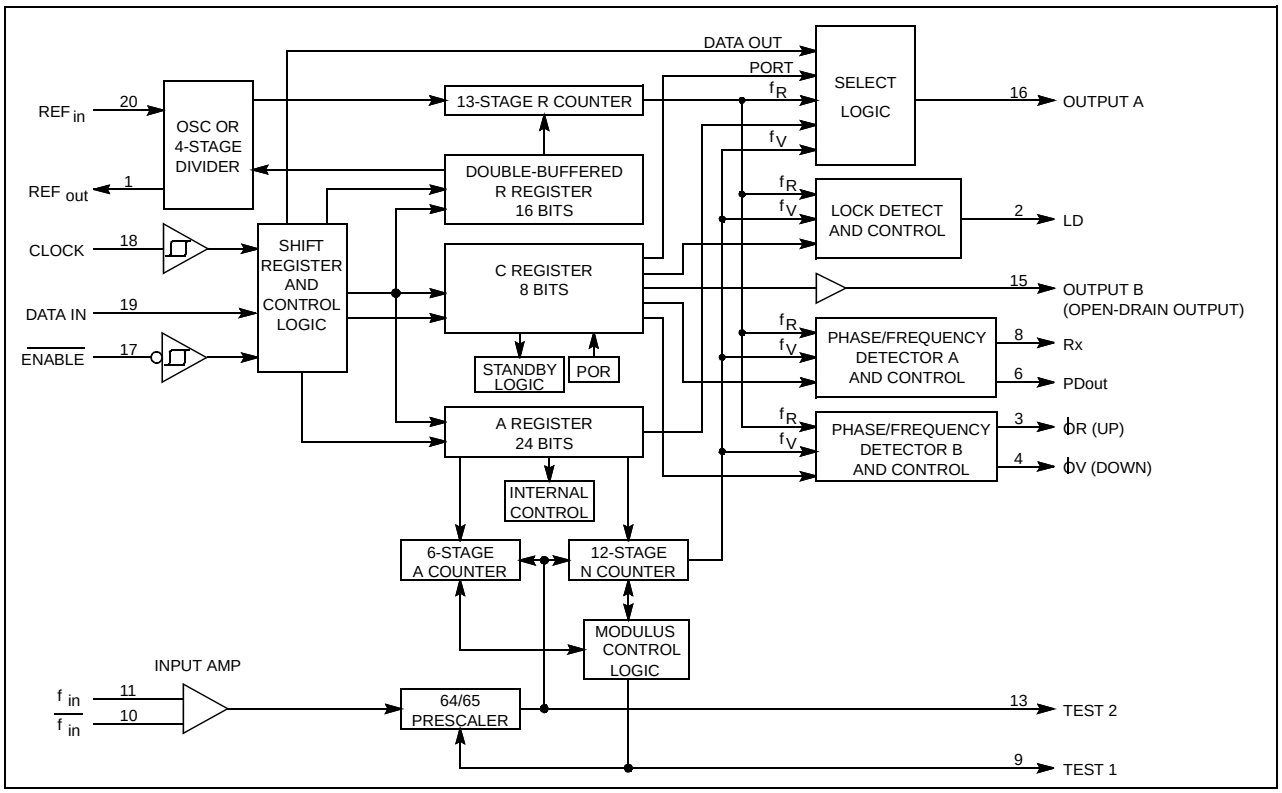


Figure 6-3 SYNTHESIZER BLOCK DIAGRAM

One input signal to the phase detector in U209 is the reference frequency (f_R). This is the 17.5 MHz TCXO frequency divided by the R (reference) counter to the channel spacing or 12.5 kHz.

The other input to the phase detector in U209 is from the VCO frequency divided down by the "N" counter and prescaler in synthesizer U209 to 12.5 kHz. The "N" counter is programmed through the synthesizer data line on J201, pin 20. U209 is programmed so that the phase detector input (f_V) is identical to the reference frequency (f_R) (12.5 kHz) when the VCO is locked on the correct frequency.

The synthesizer contains the R (reference), N, and A counters, phase and lock detectors and counter programming circuitry. Frequencies are selected by programming the three counters in U209 to divide by assigned numbers. The programming of these counters is performed by circuitry in the Main Processor Card (MPC), which is buffered and latched through the Interface Alarm Card (IAC) and fed into the synthesizer on J201, pin 20 to Data input port U209, pin 19.

Data is loaded into U209 serially on the Data input port U209, pin 19. Data is clocked into the shift registers a bit at a time by a low to high transition on the Clock input port U209, pin 18. The Clock pulses come from the MPC via the IAC to J201, pin 18.

As previously stated, the counter divide numbers are chosen so that when the VCO is operating on the correct frequency, the VCO-derived input to the phase detector (f_V) is the same frequency as the TCXO-derived input (f_R) which is 12.5 kHz.

The f_R input is produced by dividing the 17.5 MHz TCXO frequency by 1400. This division is done by the "R" counter in U209. The counter always divides by 1400 regardless of the channel number. This produces a reference frequency (f_R) of 12.5 kHz.

Since the VCO is on frequency (receive frequency minus 52.95 MHz) and no multiplication is used, the channel frequencies change in 12.5 kHz steps and the reference frequency (f_R) is 12.5 kHz for all channels selected by this receiver.

The f_V input is produced by dividing the VCO frequency using the prescaler and N counter in U209. The prescaler divides by 64 or 65. The divide number of the prescaler is controlled by the N and A counters in U209.

The N and A counters function as follows: both the N and A counters begin counting down from their programmed number. When the A counter reaches zero, it halts until the N counter reaches zero. Both counters then reset and the cycle repeats. The A counter is always programmed with a smaller number than the N counter. While the A counter is counting down, the prescaler divides by 65. Then when the A counter is halted, the prescaler divides by 64.

Example: Assume a receive frequency of 813.4875 MHz (channel 300). Since the VCO is 52.95 MHz below the receive frequency it must be 760.5375 MHz for channel 300. To produce this frequency, the N and A counters are programmed as follows:

N = 950 A = 43

NOTE: Section 8.2.5 describes how the N and A counter numbers can be calculated for other channels.

To determine the overall divide number of the prescaler and N counter, the number of VCO output pulses required to produce one N counter output pulse can be counted. In this example, the prescaler divides by 65 for 65 x 43 or 2,795 input pulses. It then divides by 64 for 64 x (950 - 43) or 58,048 input pulses. The overall divide number K is therefore (58,048 + 2,795) or 60,843. The VCO frequency of 760.5375 MHz divided by 60,843 equals 12.5 kHz which is the f_R input to the phase detector. The overall divide number K can also be determined by the following formula:
K = 64N + A

Where,
N = N counter divide number and
A = A counter divide number.

6.1.13 BUFFER AMPLIFIER

A cascode amplifier formed by Q210 and Q211 provides amplification and also isolation between the TCXO and Synthesizer U209. A cascode amplifier is used because it provides high reverse isolation. The input signal to this amplifier is from TCXO Y201. C254 provides DC blocking. Bias for the amplifier is provided by R312, R248, R249, R251 and R250. L218 is an RF choke. RF bypass is provided by C251, C252 and C253. The output of Q210/Q211 is coupled to U209 by C307.

6.1.14 LOCK DETECT

When the synthesizer is locked on frequency, the Lock Detect output on U209, pin 2 is a logic high voltage with very narrow negative-going pulses. Then when the synthesizer is unlocked, these pulses become much wider, the width may vary at a rate determined by the frequency difference of f_V and f_R. The lock detect pulses are applied to J201, pin 14 and sent to the RF Interface on J103, pin 14 for detection and sampling in the IAC.

6.1.15 BUFFER AMPLIFIER

A cascode amplifier formed by Q214 and Q215 provides amplification and also isolation between the VCO and Receiver RF stages. A cascode amplifier is used because it provides high reverse isolation. The input signal to this amplifier is coupled from VCO A006 by C268. C268 also provides DC blocking. Bias for the amplifier is provided by R294, R311, R290, R291 and R292. L222 is an RF choke and R293 lowers the Q of the coil. RF bypass is provided by C274, C356, C310, C272, C273 and C335. The output of Q214/Q215 is matched to the Receiver RF stages by C275, C276 and two sections of microstrip.

6.1.16 RF AMPLIFIERS

U210 provides the +12V source for these amplifiers. RF amplifier Q216 is biased by R296 and R295. C278 provides RF bypass from the DC line and R297 provides supply voltage isolation. A section of microstrip on the collector acts as an RF inductor. Q216 is matched to Q217 by C277, C263, C288 and two sections of microstrip.

RF amplifier/buffer Q217 is similar in design to Q216. The output of Q217 is matched to the 3 dB attenuator made up of R285/R286/R287 by two sections of microstrip and C280 provides DC blocking. L223/L224 are tuned to the receive frequency -52.95 MHz and passed to Mixer U201. This injection frequency is also coupled through C284 to U204A. CR201, R255, R254 provide DC input to U204A, pin 3. The output of U204A, pin 1 is connected to J201, pin 13 for a receive injection test point and connected to the RF Interface Board on J103, pin 13.

6.2 EXCITER

6.2.1 VCO (A007)

The Voltage-Controlled Oscillator (VCO) is formed by Q802, associated circuitry and a resonator consisting of L404 in the Exciter. The screw in L404 in the Exciter tunes the tank circuit to the desired frequency range. The VCO oscillates in a frequency range from 851-869 MHz. Biasing of Q802 is provided by R805, R806 and R807. An AC voltage divider formed by C812 and C813 initiates and maintains oscillation. C803 couples Q802 to resonator L404 in the Exciter. Resonator L404 provides the shunt inductance of the tank circuit. The shunt capacitance of the tank circuit is made primarily of C804 in series with CR802. RF choke L805 completes the DC bias path to ground.

The VCO frequency is controlled in part by DC voltage across varactor diode CR802. As voltage across a reverse-biased varactor diode increases, its capacitance decreases. Therefore, VCO frequency increases as the control voltage increases. The control line is RF isolated from tank circuit by choke L804. The amount of frequency change produced by CR802 is controlled by series capacitor C804.

The frequency is modulated in a similar manner. The transmit audio/data signal is applied across varactor diode CR801 to vary the VCO frequency at an audio rate. C802 in series with CR801 determine the amount of modulation produced by the audio signal.

6.2.2 VCO AND TCXO FREQUENCY MODULATION

Both the VCO and TCXO are modulated in order to achieve the required frequency response. If only the VCO was modulated, the phase detector in U403 would sense the frequency change and increase or decrease the VCO control voltage to counteract the change (at the lower audio frequencies inside the closed loop bandwidth of the synthesizer). If only the TCXO frequency was modulated, the VCO would not track the higher audio frequencies (those beyond the closed loop bandwidth of the synthesizer). However, by modulating both the VCO and TCXO a flat audio response is achieved. Potentiometers R425 and R446 balance the modulating signals.

There are two 3.5V sources on the Exciter board; one is a reference for the modulation amplifier to the VCO, the other is for the modulation amplifier to the TCXO.

The reference voltage on U402B, pin 5 is sent to buffer U407B, J401, pin 9 to RFIB connector J102, pin 9. The voltage leaves the RFIB on J101, pin 14 to J2, pin 27 on the backplane, to the bottom connectors via pin 7 and finally to the MAC on P100, pin 7.

With reference to the ground on the Exciter, the 3.5V reference stability is maintained by U126B/C/D on the MAC. The 3.5V DC passes through summing amplifier U129B and transmit modulation gate U118D to P100, pin 29 (Tx MOD). P100, pin 29 is connected to backplane connector J2, pin 8 and RFIB connector J101, pin 22 to J102, pin 13. The transmit modulation and 3.5V reference enter the Exciter on J401, pin 13 and is routed to U402B, pin 6. R425 sets the TCXO modulation level. The modulation signal along with the 3.5V DC is applied to U402A, pin 2.

6.2.3 ACTIVE FILTER

Q801 functions as a capacitance multiplier to provide filtering of the 12V supply to Q802. R801 and R802 provide transistor bias, and C809 provides capacitance that is effectively multiplied by the gain of Q801. If a noise pulse or other quick voltage change appears on the collector, base voltage does not change significantly because of C809. Therefore, the base current does not change and transistor current

remains constant. R803 decouples the VCO output from AC ground. L803 is an RF choke and C807, C808, C810 and C811 provide RF bypass.

6.2.4 BUFFER

A cascode amplifier formed by Q406/Q407 provides amplification and also isolation between the VCO and synthesizer. A cascode amplifier is used because it provides high reverse isolation. The input signal to this amplifier is tapped from the VCO RF output. DC blocking to the VCO is provided by C441 and to the buffer by C433. Bias for the amplifier is provided by R451, R453, R454 and R455. Q407 is a common-emitter amplifier and Q406 is a common-base with C432 providing RF bypass. L403 decouples the output from AC ground and R452 lowers the Q of L403. The amplifier is coupled by C429 and C499 to U403, pin 11.

6.2.5 SYNTHESIZER

The synthesizer inputs/outputs are shown in Figure 6-3. The synthesizer output signal is the transmit frequency. This signal is produced by a VCO (voltage-controller oscillator) that is frequency controlled by a DC voltage produced by synthesizer chip U403. This DC voltage is filtered by a loop filter made up of C805, C806 and R804 in the VCO circuitry.

Frequencies are selected by programming counters in U403 to divide by a certain number. This programming is provided through J401, pins 12, 19 and 20. The frequency stability of the synthesizer is established by the ±1.0 PPM stability of TCXO Y401. This oscillator is stable from -30°C to +60°C (-22°F to +140°F).

The VCO frequency of A007 is controlled by a DC voltage produced by the phase detector in U403. The phase detector senses the phase and frequency of the two input signals and causes the VCO control voltage to increase or decrease if they are not the same. When the frequencies are the same, the VCO is then "locked" on frequency.

The synthesizer contains the R (reference), N, and A counters, phase and lock detectors and counter programming circuitry.

One input signal to the phase detector in U403 is the reference frequency (f_R). This frequency is the 17.5 MHz TCXO frequency divided by the reference counter to the channel spacing or 12.5 kHz. The other input signal (f_V) is the VCO frequency divided by the "N" counter in U403. The counters are programmed through the synthesizer data line on J401, pin 20. Each channel is programmed by a divide number so that the phase detector input is identical to the reference frequency (f_R) when the VCO is locked on the correct frequency.

Frequencies are selected by programming the three counters in U403 to divide by assigned numbers. The programming of these counters is performed by circuitry in the Main Processor Card (MPC), buffered and latched through the Interface Alarm Card (IAC) and fed into the synthesizer on J401, pin 20 to Data input port U403, pin 19.

Data is loaded into U403 serially on the Data input port U403, pin 19 when U403, pin 17 is low. Data is clocked into the shift registers a bit at a time by a low to high transition on the Clock input port U403, pin 18. The Clock pulses come from the MPC via the IAC to J401, pin 19.

As previously stated, the counter divide numbers are chosen so that when the VCO is operating on the correct frequency, the VCO-derived input to the phase detector (f_V) is the same frequency as the TCXO-derived input (f_R). The f_R input is produced by dividing the 17.5 MHz TCXO frequency by 1187. This produces a reference frequency (f_R) of 12.5 kHz. Since the VCO is on frequency and no multiplication is used, the frequencies are changed in 12.5 kHz steps. The reference frequency is 12.5 kHz for all frequencies selected by this Exciter.

The f_V input is produced by dividing the VCO frequency using the prescaler and N counter in U403. The prescaler divides by 64 or 65. The divide number of the prescaler is controlled by the N and A counters in U403. The N and A counters function as follows:

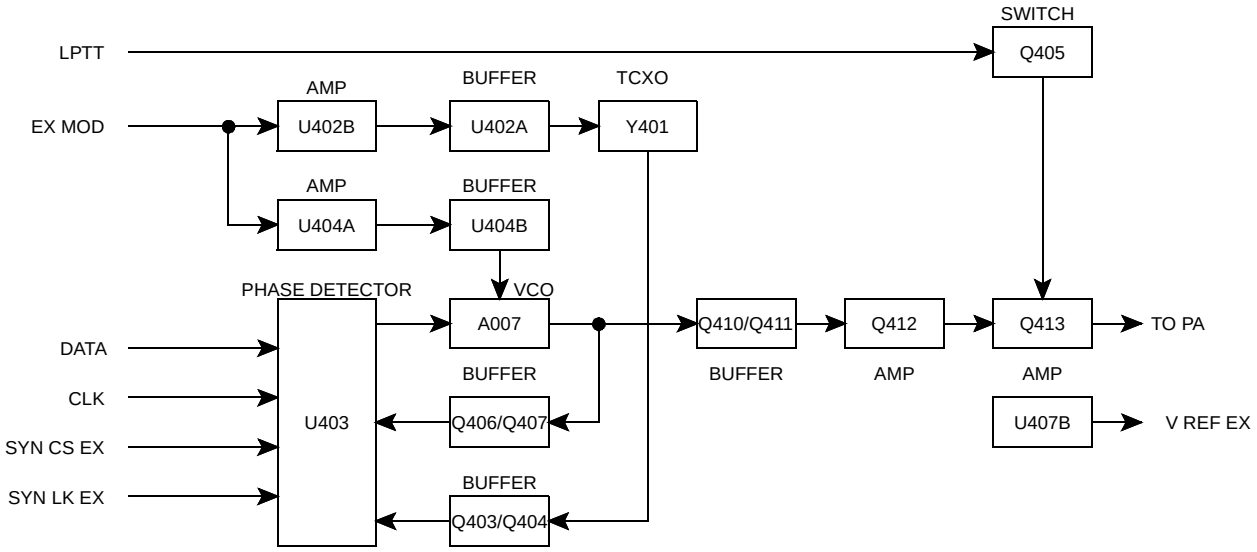


Figure 6-4 EXCITER BLOCK DIAGRAM

Both the N and A counters begin counting down from their programmed number. When the A counter reaches zero, it halts until the N counter reaches zero. Both counters then reset and the cycle repeats. The A counter is always programmed with a smaller number than the N counter. While the A counter is counting down, the prescaler divides by 65. Then when the A counter is halted, the prescaler divides by 64.

Example: To illustrate the operation of these counters, assume a transmit frequency of 858.4875 MHz (channel 300). Since the VCO is the channel frequency for transmit this frequency is used. To produce this frequency, the N and A counters are programmed as follows:

N = 1073 A = 7

To determine the overall divide number of the prescaler and N counter, the number of VCO output pulses required to produce one N counter output pulse can be counted. In this example, the prescaler divides by 65 for 65 x 7 or 455 input pulses. It then divides by 64 for 64 x (1073 - 7) or 68,224 input pulses. The overall divide number K is therefore (68,224 + 455) or 68,679. The VCO frequency of 858.4875 MHz divided by 68,679 equals 12.5 kHz which is the f_R input to the phase detector. The overall divide number K can also be determined by the following formula:

K = 64N + A

Where,
N = N counter divide number and
A = A counter divide number.

NOTE: Section 8.2.5 describes how the N and A counter numbers can be calculated for other channels.

6.2.6 BUFFER AMPLIFIER

A cascode amplifier formed by Q403 and Q404 provides amplification and also isolation between the TCXO and Synthesizer U403. A cascode amplifier is used because it provides high gain, high reverse isolation and consumes only a small amount of power. The input signal to this amplifier is coupled from TCXO Y401, pin 5 by C420. C420 also provides DC blocking. Bias for the amplifier is provided by R430, R431, R432, R433 and R428. L402 is an RF choke. RF bypass is provided by C416, C418 and C419. The output of Q403/Q404 is coupled to U403, pin 20 by C417.

6.2.7 BUFFER AMPLIFIER

A cascode amplifier formed by Q406 and Q407 provides amplification and also isolation between the VCO and Synthesizer U403. A cascode amplifier is used because it provides high gain, high isolation and consumes only a small amount of power. The input signal to this amplifier is coupled from VCO A007, pin 6 by C433. C433 also provides DC blocking. Bias for the amplifier is provided by R450, R451, R453, R454 and R455. L403 is an RF choke. RF bypass is provided by C430, C431 and C479. The output of Q406/Q407 is coupled to U403, pin 11 by a non-polarized capacitor formed by C429/C499.

6.2.8 LOCK DETECT

When the synthesizer is locked on frequency, the Lock Detect output on U403, pin 2 is a high voltage with narrow negative-going pulses. When the synthesizer is unlocked, the negative-going pulses are much wider, the width may vary at a rate determined by the frequency difference of f_V/f_R.

The locked or unlocked condition of the synthesizer is filtered by R440/C423 and applied to J401, pin 16, then sent to the RF Interface on J102, pin 16 for detection.

6.2.9 BUFFER AMPLIFIER

A cascode amplifier formed by Q410/Q411 provides amplification and also isolation between the VCO and exciter RF stages. A cascode amplifier is used because it provides high gain, high isolation and consumes only a small amount of power. The input signal to this amplifier is tapped from VCO A007, pin 4 by C441. C441 also provides DC blocking. Bias for the amplifier is provided by R464, R465, R466, R467 and R468. L406 is an RF choke and R483 lowers the Q of the coil. RF bypass is provided by C434, C442, C445, C443, C444 and C480. The output of Q410/ Q411 is matched to the Exciter RF stages by C446, R450 and two sections of microstrip.

6.2.10 RF AMPLIFIERS

RF amplifier Q412 is biased by CR402, R469, R470 and R472. C448 provides RF bypass from the DC line and R471/R472 provide supply voltage isolation. A section of microstrip on the collector acts as an RF choke to the supply line. Q412 is matched to Q413 by C449, C451 and two sections of microstrip.

RF amplifier/buffer Q413 is similar in design to Q412. The collector voltage of Q413 is switched by Q405. When the Logic Push-To-Talk (LPTT) on J401, pin 11 is low Q405 turns on and conducts the 15V supply to the collector of Q405 and to Q413. The output of Q413 is matched to 50 ohms by two sections of microstrip and C465 provides DC blocking. A 3 dB attenuator follows amplifier Q413. The RF output of the Exciter is on coaxial connector J402 to the Power Amplifier.

6.3 75W POWER AMPLIFIER

6.3.1 AMPLIFIER/PREDRIVER

RF input to the PA from the Exciter is through a coaxial cable and connector to WO511. C501 couples the RF to 50 ohm microstrip that connects the input to U501. U501 is a 6W amplifier/pre- driver operating in the 851-869 MHz range.

Power control is connected to WO505 from the RF Interface board (RFIB). RF is filtered from the control voltage line by various capacitors and inductors to U501, pin 2. This control voltage regulates the RF output of the amplifier on U501, pin 4 to approximately 5W.

6.3.2 DRIVER

The output of U501 passes through several sections of 50 ohm microstrip and matching capacitors to the emitter of Q501. Driver Q501 is a common base amplifier with a normal output of approximately 22W. Supply voltage is RF bypassed by various capacitors and microstrip. C519, C520, C521 and microstrip match the output of the driver to 50 ohms at J501. A501 couples driver output to the input splitter of the finals.

6.3.3 FINAL AMPLIFIERS

Q502 and Q503 are combined 60W amplifiers. The 22W RF input from J501 on the output of driver Q501 is applied to WO514 through a coaxial cable and connector. A 50 ohm microstrip connects the RF to a

70.7 ohm Wilkinson splitter and then to the emitter of each common-base amplifier. The 60W outputs on the collectors of the amplifiers are combined using a Wilkinson combiner. Q502 has a half-wave transmission line on the input and Q503 has a half-wave on the output. These T-lines are used to drive the 60W amplifiers out of phase. The output of the combiner is fed from WO513 directly to the forward/reverse power detect board.

The Wilkinson splitter and combiner provide the capability to split the drive input and combine the final outputs while maintaining isolation between the two final amplifiers. The combiner consists of two quarter-wave transmission lines and a balancing resistor. During normal operation, a signal of relatively equal phase and amplitude is present on both ends of the balancing resistor. Therefore, no current flows and no power is dissipated in the balance resistor. If one final failed, the other final of a pair would continue to function.

6.3.4 POWER DETECTORS

Electromagnetic coupling is used to sample the output of each final amplifier. The RF is then fed to a rectifier to create a voltage indicative of the power output. The outputs of U504A and U502B are monitored by the repeater software through the RF Interface Board. If a final amplifier fails, the software will reduce the output power to prevent overdriving the remaining final amplifier.

6.3.5 THERMAL SENSOR

Thermal protection is provided by temperature sensor U503. The operating range of the sensor is from -30° C to 100° C (-22° F to 212° F). CR505 is used to reference U503 above ground to allow the sensor to read below 0° C. Amplifier U502A sends the output of U503 through WO509 to the RF Interface Board. The RF Interface Board reduces the power amplifier to half power (via the MPC) if the temperature reading is too high and turns the fan on and off (not via the MPC). The fan is turned on at approximately 50°C and off again at 42°C.

6.3.6 FORWARD/REVERSE POWER DETECT, CIRCULATOR, LOW-PASS FILTER

The power amplifier output is directly coupled to the forward/reverse power detect board via a jumper. The output then enters the circulator and exits to the low-pass filter board and the antenna jack for a minimum power output of 75W at the default setting. If an antenna is not connected, the circulator connects the output power to R685.

Forward and reverse power are electromagnetically coupled from the input and reflected ports of the circulator. R663/R680 calibrate the forward and reverse sense levels. The sensed levels are coupled to the RF Interface Board and software.

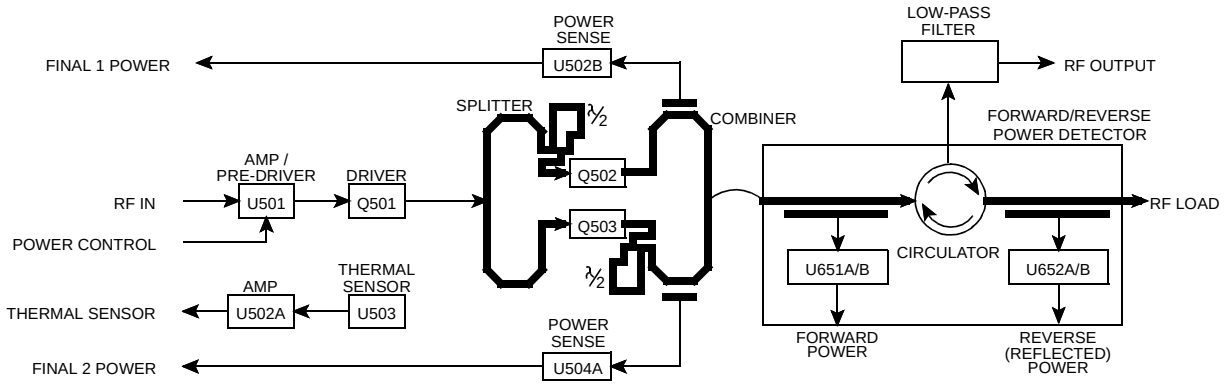


Figure 6-5 75W POWER AMPLIFIER BLOCK DIAGRAM

6.4 175W POWER AMPLIFIER

6.4.1 GAIN BLOCK

RF input to the PA from the Exciter is through a coaxial cable and connector to WO509. RF is directly coupled to 50 ohm microstrip that matches the input to U501. U501 is a 20W amplifier/pre- driver operating in the 851-869 MHz range.

Power control is connected to WO505 from the RF Interface board (RFIB). RF is filtered from the control voltage line by various capacitors and inductors to U501, pin 2. This control voltage regulates the RF output of the amplifier on U501, pin 5 to approximately 12W (see Figure 6-6).

6.4.2 DRIVER

The output of U501 passes through several sections of 50 ohm microstrip and matching capacitors to the emitter of Q502. Driver Q502 is a common base amplifier with an output of approximately 60W. Supply voltage is RF bypassed by various capacitors and microstrip. C551 and C568 match the output of the driver to the input impedance of the splitter to the final amplifiers.

6.4.3 FINAL AMPLIFIERS

The output of the driver is DC blocked through C552 and is connected to the first 70.7 ohm splitter with a 50 ohm microstrip. One output of the first splitter is sent directly to another 70.7 ohm splitter to feed Q703/Q704. The second output of the first splitter is connected to the splitter driving Q701/ Q702 through a half-wave 50 ohm microstrip. The 60W output of Q701/Q702 is combined through a 70.7 ohm quarter-wave Wilkinson combiner and fed through a 50 ohm microstrip to the final 50 ohm combiner.

Outputs from amplifiers Q703/Q704 are fed to the final combiner through 50 ohm microstrip that is a half-wavelength longer than the other side. The 25 ohm output impedance of the final combiner is transformed to 50 ohms through a quarter-wave, 35.35 ohm microstrip. The output of the quarter-wave transformer is fed directly into the forward power detector via W510.

The Wilkinson combiners provide the capability to split the drive input and combine the final outputs while maintaining isolation between the final amplifiers. Each combiner consists of two quarter-wave transmission lines and a balancing resistor. During normal operation, a signal of relatively equal phase and amplitude is present on both ends of the balancing resistor. Therefore, no current flows and no power is dissipated in the resistor. If one final failed, the other final of a pair would continue to function.

6.4.4 POWER DETECTORS

Electromagnetic coupling is used to detect the output of each final amplifier. The detected RF is then fed to a rectifier to create a voltage output indication of the power output. The outputs are monitored by the RF Interface Board and the station software. If any of the finals fail, the software will reduce the output power to prevent overdriving the remaining final amplifier.

6.4.5 THERMAL SENSOR

Thermal protection is provided by temperature sensor U503. The operating range of the sensor is from 0 to 100° C (32° F to 212° F). Amplifier U502A sends the output of U503 to WO519 and to the RF Interface Board. The RF Interface Board reduces the power amplifier to half power (via the MPC) if the temperature reading is too high and turns the fan on and off (not via the MPC). The fan is turned on at approximately 50°C and off again at 42°C.

6.4.6 FORWARD/REVERSE POWER DETECT, CIRCULATOR, LOW-PASS FILTER

The power amplifier output is directly coupled to the forward/reverse power detect board via a jumper. The output then enters the circulator and exits to the low-pass filter board and the antenna jack for a power output of 175W (±7W). If an antenna is not connected, the circulator connects the output power to R685.

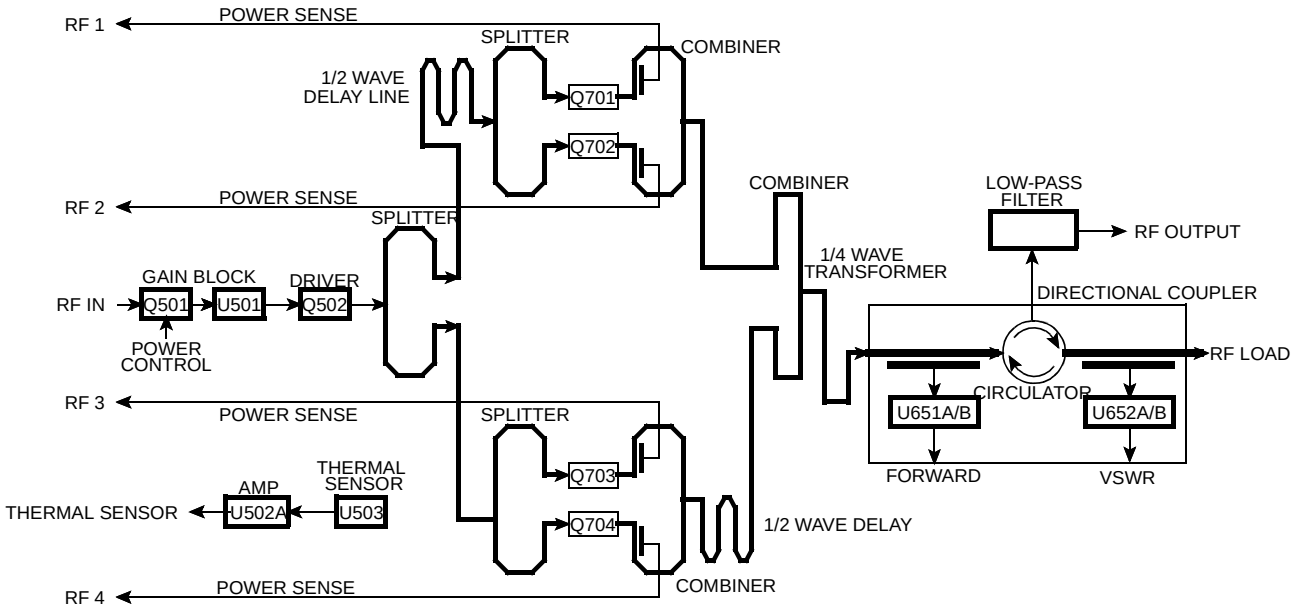


Figure 6-6 POWER AMPLIFIER BLOCK DIAGRAM

Forward and reverse power is electromagnetically coupled to the detectors on the input and reflected ports of the circulator. R663 and R680 calibrate the forward and reverse sense levels. The sensed levels are coupled to the RF Interface Board and software.

6.5 RF INTERFACE BOARD

The RF Interface Board (RFIB) connects the Receiver, Exciter and Power Amplifier to the backplane and power supply (see Figure 6.10).

The input and output connectors for the RF Interface Board are defined as follows.

6.5.1 POWER CONNECTOR

The power supply is connected to the RF Interface Board when the RF module is inserted into the station cabinet (see Figure 10-5). The jack portion of the connection is on the RF Interface Board, the plug portion is attached to the station cabinet.

P101/P102 +26.5V DC - Supply voltage to PA. +26.5V ±1%, 12A at 75W and 25A at 175W.

P103 +15V DC - Supply voltage to Exciter, Receiver and Power Control. 15V ±1%, 5.5A max.

P104/P105 GROUND - Ground return for the RF assembly.

6.5.2 SIGNAL CONNECTOR (J101)

This is the signal interface connector (36 pin) that connects the RFIB to the backplane connector J2 (34 pin) through cable assembly A8.

Pin 1 GROUND

Pin 1 carries ground current between the RF Interface board and Backplane board.

Pin 2 PC STR

Pin 2 is the power Control Strobe. This is normally low until after the power control data is shifted into the power control register. Then the strobe line goes high and back to low. The clock or data lines cannot be changed until after the strobe is set.

Pin 3 HS CS EX

Pin 3 is not used at this time.

Pin 4 GROUND

Pin 4 carries ground current between the RF Interface board and Backplane board.

Pins 5-6 UNUSED

Pin 7 RX WBAND

The wide band audio is from the receive audio demodulator U202 and goes to the MAC in the Controller card cage. The typical amplitude is 387 mV RMS (-6 dBm) and 2V DC with Standard TIA Test Modulation into the receiver. Little wave shaping is done on the receiver board other than a 31 kHz RC LPF which strips off the 450 kHz IF. Buffering is done with an op-amp.

Pin 8 RF DATA A

Data A (U105, pin 11) is the least significant bit (LSB) in the 3 multiplex chips located on the RFIB. This pin is a CMOS input from the Controller requiring a logic high for activation.

Pin 9 RF DATA C

Data C (U105, pin 9) is the most significant bit (MSB) in the 3 multiplex chips located on the RFIB. This pin is a CMOS input from the Controller requiring a logic high for activation.

Pin 10 RF MUX2 INH

The Multiplexer-2 Inhibit (U106, pin 6) is a CMOS input from the Controller that inhibits (disables) the output from the RF 2 Multiplexer with a logic high.

Pin 11 RF CLK

The clock will control the synthesizer chip and power control circuit when loading. This pin is a TTL input from the Controller.

Pin 12 HS CS RX

Pin 12 is not used at this time

Pin 13 RF MUX1 INH

The Multiplexer-1 Inhibit (U105, pin 6) is a CMOS input from the Controller that inhibits (disables) the output from the RF 1 Multiplexer with a logic high.

Pin 14 V REF EX

This is the 3.5V reference to the Exciter TCXO. 3.5V from the Exciter is passed from J102, pin 9 to this pin and the backplane. The voltage then passes through the MAC and back to the backplane to J101, pin 22 with the TX MOD. These are connected to J102, pin 13 back to the Exciter.

Pins 15-18 UNUSED

Pin 19 RF MUX3 INH

The Multiplexer-3 Inhibit (U104, pin 6) is a CMOS input from the Controller that inhibits (disables) the output from the RF 3 Multiplexer with a logic high.

Pin 20 LPTT

The Logic Push-To-Talk is an open collector from the Controller. It has a sink capability of 20 mA and a maximum voltage rating of 18V. The transmitter should produce power when this pin is a logic low.

Pin 21 SYN CS EX

This input goes low to enable the loading of data into the exciter synthesizer chip U403.

Pin 22 TX MOD

The audio from the MAC in the Controller processes a number of inputs to the station to produce the signals on this pin. This signal goes through the RFIB and then to the Exciter. A 707 mV RMS sine wave (2V P-P) at 1 kHz produces 60% of system deviation in the transmitter. The source impedance is low and the input impedance is less than 10k ohms.

Pin 23 GROUND

Pin 23 carries ground current between the RFIB and Chassis Backplane.

Pin 24 UNUSED

Pin 25 LOGIC CONTROL TO FANS

Pin 25 is in parallel with the temperature sensor.

Pin 26 RF DATA B

The Data B (U105, pin 10) is the middle significant bit in the three multiplex chips located on the RFIB. This pin is a CMOS input from the Controller requiring a logic high for activation.

Pin 27 A D LEVEL

20 lines (of the possible 24) of RF functions sampled are multiplexed to the Controller through this pin using three multiplex chips.

- RF Forward Power Sense
- RF Power Sense Device 1
- RF Power Sense Device 2
- RF Power Sense Device 3
- RF Power Sense Device 4
- RF Reflected Power Sense
- PA Temperature
- Transmit Audio Modulation
- High Stability Exciter Lock Detector
- Exciter Lock Detector
- Receiver Detector Audio
- Receive Signal Strength Indicator
- Receiver Injection Level
- High Stability Receive Lock Detector
- Receiver Lock Detector
- Fan Current 1
- Fan Current 2
- Fan 1 On Sense
- Power Supply Temp
- Battery Voltage

Pin 28 RF DATA

A data pin with TTL levels from the Controller which has the dual role of loading the synthesizer chips and adjusting the power control D/A lines for proper output power. Up to four synthesizer chips and a shift-register could be connected to this pin.

Pin 29 SYN CS RX

This input goes low to enable the loading of data into the receiver synthesizer chip U209.

Pin 30 RSSI

This pin is the Receive Signal Strength Indication to the Controller. This RSSI is used for tune-up of the Receiver front-end during factory test mode. The dynamic range is 60 dB. It has an output from an op-amp with the voltage going from 0.5V to 4.5V. The level has an adjustment in the Receiver.

Pin 31 GROUND

Pin 31 carries ground current between the RFIB and Chassis Backplane.

Pins 32-36 UNUSED

6.5.3 FAN CONNECTOR (J104)

The outputs to the fan connectors are 4-pin plug-in terminals that supply DC voltage. The plug on the fan is a 2-pin connector. The plug-in terminals are located on the back of the RFIB.

Pin 1 FAN 1 LOW

Pin 1 is the ground return for Fan 1.

Pin 2 FAN HI

Pin 2 carries the voltage to Fan 1. The current is 1/4A nominal at 20V to 30V. This pin goes high when the PA heat sensor rises above 50°C and goes low below 45°C.

Pin 3 FAN 2 LO

Pin 3 is the ground return for Fan 2 in 175W repeaters.

Pin 4 FAN HI

Pin 4 carries the voltage to Fan 2 in 175W repeaters. The Voltage is 20V-30V at 1/4A nominal. Pin 4 goes high when the PA heat sensor rises above 50°C and goes low below 45°C.

6.5.4 POWER AMPLIFIER CONNECTIONS

WO 115 POWER SENSE

This capacitive feedthrough pin is at +15V DC to the Power Detect Board.

W116 +26.5V DC

This capacitive feedthrough pin is at +26.5V DC and carries the PA current, 25A nominal at 175W from P102 to the Power Amplifier board.

W117 +26.5V DC GROUND

This capacitive feedthrough pin carries ground current from P105 to the Power Amplifier board. It must be capable of carrying up to 25A.

W118 +15V DC

This capacitive feedthrough pin connects +15V DC P103 to the PA, Exciter, and Forward/Reverse Power Detect boards. Maximum current handling is 6A (4A nominal at 175W).

WO 119 NOT USED

WO 120 CTRL OUT

This capacitive feedthrough pin carries the output of the power control driver on the RFIB to the power control pin of the power module on the Power Amplifier board. The voltage varies from 0V-15V with current as high as 0.5A.

WO 121 FWD PWR

This capacitive feedthrough pin is the forward power sense line. It is a voltage source that is a function of the output power of the Power Amplifier. The voltage level will be between 0V-5V and drive a 10k ohm load. A typical voltage of 3.9V correlates to 160W out of the PA. This line goes through the multiplexers and A D LEVEL line to the Controller for processing.

WO 122 RF OUT 1

This capacitive feedthrough pin is a voltage source that is a function of the output power of Q701. The voltage level will be between 0V-5V and drive a 10k ohm load. This line goes through the multiplexers and A D LEVEL line to the Controller for processing.

WO 123 RF OUT 2

This capacitive feedthrough pin is a voltage source that is a function of the output power of Q702. The voltage level will be between 0V-5V and drive a 10k ohm load. This line goes through the multiplexers and A D LEVEL line to the Controller for processing.

WO 124 RF OUT 3

This capacitive feedthrough pin is a voltage source that is a function of the output power of Q703. The voltage level will be between 0V-5V and drive a 10k ohm load. This line goes through the multiplexers and A D LEVEL line to the Controller for processing.

WO 125 RF OUT 4

This capacitive feedthrough pin is a voltage source that is a function of the output power of Q704. The voltage level will be between 0V-5V and drive a 10k ohm load. This line goes through the multiplexers and A D LEVEL line to the Controller for processing.

WO 126 REFL PWR

This capacitive feedthrough pin is the reflected power sense line. It is a voltage indicative of the power reflected due to a mismatch. The voltage produced typically is such that less than a 3:1 VSWR will not trigger alarms and when VSWR = 6:1 the controller reduces power. The voltage level is between 0V-5V and drives a 10k ohm load. This line goes through the multiplexers and A D LEVEL line to the Controller for processing. The time to sense and reduce the power takes several seconds.

WO 127 TEMP

This capacitive feedthrough pin is the temperature sense line of the Power Amplifier. It will be a linearly variable function of temperature ranging from

0V-5V output and 0°C to +100°C (+32°F to 212°F) input when driving a 10k ohm load. The primary functions of this line are for fan on/off and PA power reduction. The fan should be turned on at 50°C and off at 45°C. The PA should have power reduced when 90°C (194°F) is reached and with absolute turn-off at 95°C (203°F). This line goes through the multiplexers and A D LEVEL line to the Controller for processing.

WO147 RF DETECT PRE-DRIVER

This senses power out of the pre-driver. It is used to limit the power out of the pre-driver to 0.6 dB over 175W at room temperature. The 75W repeater limits to 0.6 dB over 75W.

W143 +26V DC

This is the +26.5V DC source to the RFIB from P101.

W144 +15V DC

This is the +15V DC source to the RFIB from P103.

W145 GROUND

W145 carries ground current from P104 to the RFIB.

6.5.5 EXCITER CONNECTOR (J102)

The connector from the Exciter (J401) to the RF Interface board (J102) links the Exciter to the MPC in the Controller Backplane.

Pin 1 VCC1

The voltage on this pin is a fused +15V ±1%, nominal current of 0.5A. It provides current to the Exciter from the RFIB.

Pins 2-8 GROUND

Pin 9 +3.5V DC

Pin 9 is the +3.5V DC TCXO reference voltage from the Exciter to the MAC.

Pin 10 GROUND

Pin 11 LPTT

The Logic Push-To-Talk (LPTT) is an open collector from the Controller. It has a sink capability of 20 mA nominal and a voltage rating of 18V maximum. The transmitter should produce power when this pin is a logic low.

Pin 12 SYN CS EX

Pin 12 is the Exciter synthesizer chip select. It allows data input to the synthesizer chip when the line is pulled to a logic low.

Pin 13 TX MOD

The audio from the MAC in the Controller processes a number of inputs to the station per the TIA specifications to produce the signal on this pin. This signal goes through the RFIB to the Exciter. A 707 mV RMS (2V P-P) sine wave at 1 kHz provides 60% of system deviation in the transmitter. The DC voltage on the line is 3.5V ±0.1V. The source impedance should be low (output of an op-amp or analog switch < 200 ohms) and the input impedance will not be less than 10k ohms.

Pins 14-15 GROUND

These pins carry ground current between the RFIB and the Exciter board.

Pin 16 SYN LK EX

Pin 16 is the Exciter synthesizer lock detector output. The synthesizer is locked with a TTL logic high state.

Pin 17 HS LK EX

Pin 17 is not used at this time.

Pin 18 HS CS EX

This input is not used at this time.

Pin 19 RF CLK

The clock controls the Exciter synthesizer when loading. The input source in the Controller is TTL with the speed determined by the synthesizer chip. There could be as many as four synthesizers and a shift register.

Pin 20 RF DATA

Pin 20 is a data pin from the Controller which has the dual role of loading the synthesizer chip and adjusting the power control D/A lines for proper output power. The data has TTL levels. Up to four synthesizer chips and a shift register could be connected to this pin.

6.5.6 RECEIVER CONNECTOR (J103)

The connector from the Receiver (J201) to the RF Interface board (J103) links the Receiver to the MPC in the Controller Backplane.

Pin 1 VCC1

Pin 1 is fused +15V ±1% with a nominal current of 1A provides current from the RFIB to the Receiver.

Pins 2-6 UNUSED

Pin 7 RSSI

This pin is the Receive Signal Strength Indicator (RSSI) to the Controller. The RSSI is used for tune-up of the Receiver front-end during test mode. The dynamic range is 60 dB. Output from an op-amp with the voltage going from 0.5V to 4.5V. The level has an adjustment in the Receiver.

Pin 8 UNUSED

Pin 9 RX WBAND

The receive wide band audio is from the demodulator and goes to the Main Audio Card (MAC) in the Controller card cage. The typical amplitude is 387 mV RMS (-6 dBm) and 2V DC with Standard TIA Test Modulation into the Receiver. Little wave shaping is done on the Receiver board other than a 31 kHz RC LPF which strips off the 450 kHz IF. Buffering is done with an op-amp which can drive a 10k ohm load.

Pin 10 UNUSED

Pin 11 GROUND

Pin 11 carries ground current between the RFIB and the Receiver board.

Pin 12 SYN CS RX

Pin 12 is the Receiver synthesizer chip select. This chip is the same part as used in the Exciter. A low enables loading the Synthesizer.

Pin 13 RX INJ

This pin is the power sense for the Receiver injection. It is a linear voltage source that is a function of the injection power. The voltage level will be between 0V - 5V and be able to drive a 10k ohm load.

Pin 14 SYN LK RX

Pin 14 is the main synthesizer lock detector output for the Receiver. The synthesizer is locked with a TTL logic high state.

Pin 15 GROUND

Pin 15 carries ground current between the RFIB and the Receiver board.

Pin 16 HS CS RX

Pin 16 is not used at this time.

Pin 17 GROUND

Pin 17 carries ground current between the RFIB and the Receiver board.

Pin 18 RF CLK

The clock controls the Receiver synthesizers when loading. The input source in the Controller is TTL with the speed determined by the synthesizer chip. There could be as many as four synthesizers and a shift register.

Pin 19 HS LK RX

Pin 19 is not used at this time.

Pin 20 RF DATA

Pin 20 is a data pin from the Controller which has the dual role of loading the synthesizer chips and adjusting the power control D/A lines for proper output power. The data has TTL levels. Up to four synthesizer chips and a shift register could be connected to this pin.

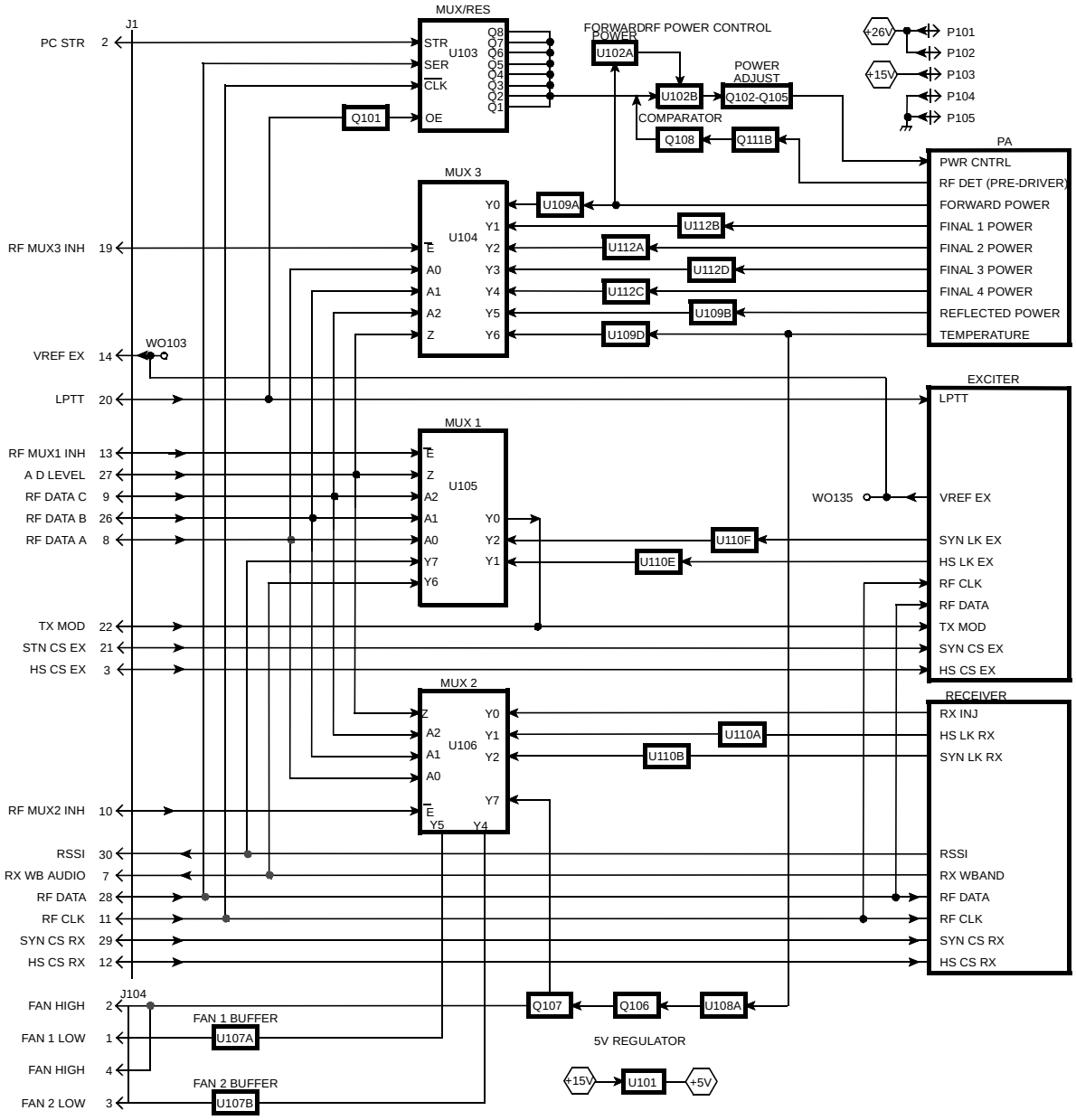


Figure 6-7 RF INTERFACE BOARD BLOCK DIAGRAM

6.6 800W POWER SUPPLY

WARNING

This power supply contains voltage potentials greater than 400V. Considering the dangerous voltages and the complexity of the switch-mode power supply, it is strongly recommended the power supply be returned to E.F. Johnson for repair (see Section 1.8).

6.7 FILTER BOARD

AC power is brought into the power supply through the IEC connector in the front of the power supply (see Figure 2-1). This connector is attached to the EMI filter assembly, Part No. 023-2000-820. The filter contains common mode and differential mode filtering such that the supply complies with FCC Class-A regulations. In addition to the filter components (C1, C2, L1, C3, C4, L2, C5) R1 is used to discharge the filter capacitors when AC is removed. Metal-oxide varistors (RV001/RV002) are placed across the line on the input and output of the EMI filter that clamp transients on the AC line to prevent damage to the power supply. The AC power is fused with F001 after the connector and before the filter. Replace fuse with a 15A/250V (314015) fuse.

At the output of the filter board is a bridge rectifier. The rectifier is heat sunk to the filter bracket through a Grafoil thermal interface pad. Filtered AC power is connected to the main board via wires W001 and W003. Filter and rectified current is brought to the main board via wires W004 and W005. The safety ground is connected from the filter board to a stud in the chassis through W002.

6.7.1 POWER FACTOR CORRECTION

The power factor switching frequency is set at 87.5 kHz, ±5 kHz. The average current mode boost converter is comprised of L107, Q101, CR145, C110, C111. Half of U102 is used for power factor correction. RT101/RT102 are negative temperature coefficient thermistors that limit the in-rush current to C110/C111. The resistor network connected to CR104 charges up C106/C107 to +18Voff the line. This provides the bias voltage required to start the controller IC U102. Once the IC turns on current is being switched on L107. A small tap winding on L107 provides sustaining current to the U102. When AC is first connected it could take several seconds for C106/C107 to charge to +14V before the unit starts.

U102 samples the input voltage through R105/R106/R107; the input current through T103/T104/CR146/CR108/R113/R114; and the output voltage through the divider at R127. U102 modulates the duty cycle to MOSFET Q101 such that the input current is shaped like and in phase with the input voltage. The controller has two feedback loops; a voltage loop to keep the 400V constant and a current loop to keep input current correct. Compensation for the current error amp is C120/R141/C121 on U102, pin 1. Compensation for the voltage error amp is provided by C127/C142/C126 on U102, pin 16. U102, pin 4 and associated circuitry automatically adjust the Power Factor Correction (PFC) for input voltage (100-240V AC), line frequency (50-60 Hz) and load on the power factor.

NOTE: The output voltage of the power factor section is at 400V DC. This voltage is bled off slowly. After turning off, it can take more than 5 minutes to discharge.

6.7.2 MAIN PULSE WIDTH MODULATOR

The +26.5V output is created from a two-transistor forward converter Q116/Q118. It uses the 400V output of the power factor correction on C110/C111 for an input voltage. The same controller IC (U102) drives the +26.5V stage. This stage runs at exactly twice the power factor correction frequency and uses trailing edge modulation. The pulse width modulator uses the PFC supplied current for modulation scheme that reduces ripple current in C110/C111.

The output of the IC, U102, pin 11 is fed to a level shifting gate drive network comprised of C139, C140, T106, C136, C197, C137 and C228. Each MOSFET (Q116, Q118) of the two-transistor forward converter has a gate protection zener diode CR117, CR120 respectively. In addition, each power MOSFET has a gate turnoff network.

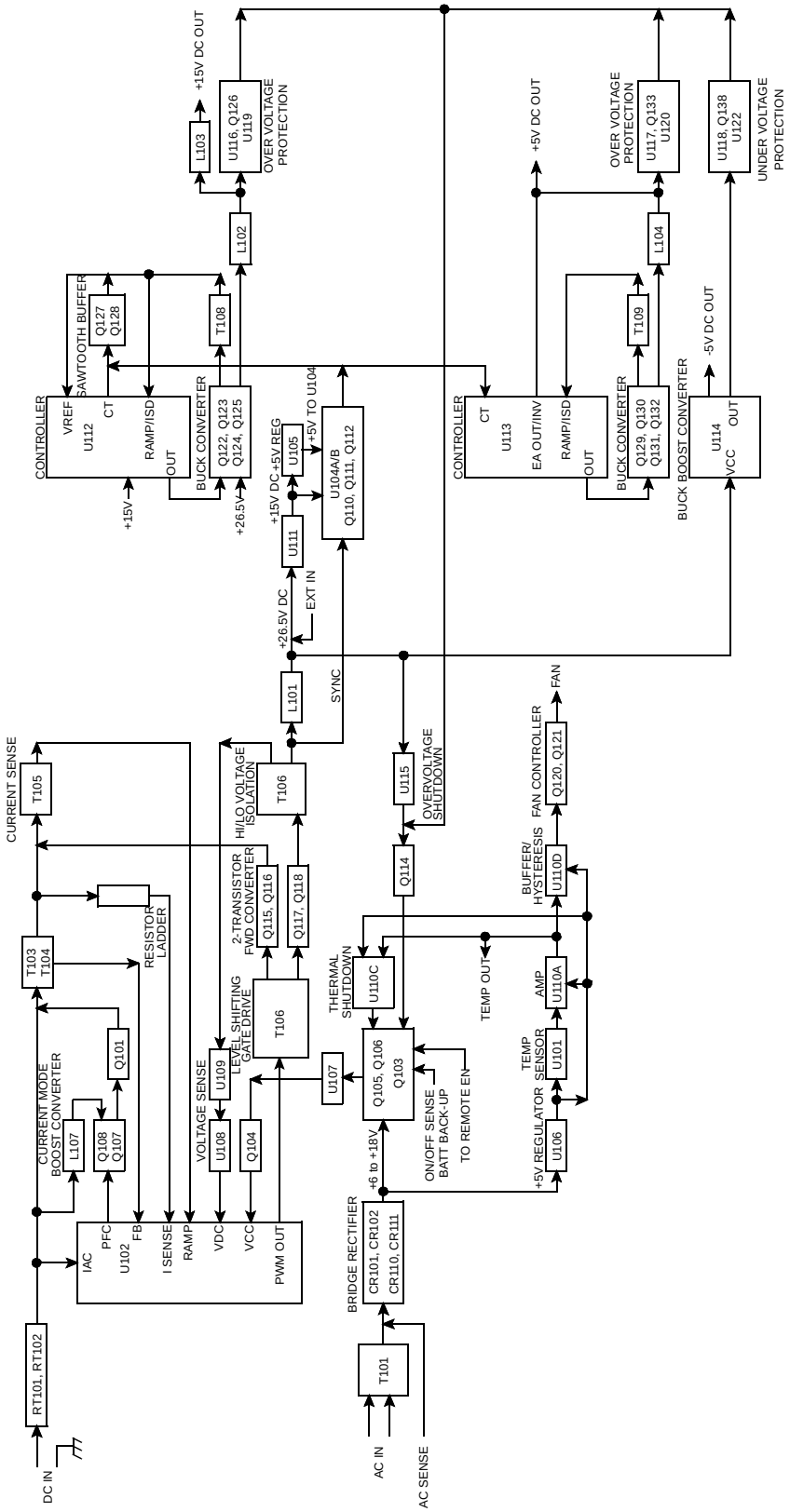


Figure 6-8 BLOCK DIAGRAM

In operation, the power MOSFETs Q116, Q118 are on for approximately one-third of the period providing current to the primary side of T107. During that time CR121 is forward conducting and charging L101. When the MOSFETs are switched off, the magnetizing current of T107 continues to flow through CR118, CR119. These diodes place 400V across the transformer in opposite polarity that resets the transformer core. During the off period CR128 is free wheeling and L101 is discharging. Transformer T107 provides the isolation between the low voltage and high voltage sections.

The +26.5V pulse width modulator is peak current mode controlled. This type of converter requires current and voltage sense. T105, CR112, R125, R146 and C125 provide the current sense circuit. The voltage sense circuit is U109 and the associated circuitry on the isolated side of the supply.

An opto-isolator is used to cross the boundary from high to low voltage sections. In the event of an over-voltage condition (>+32V) U115 and associated components turn the power supply off. This shutdown mechanism latches the power supply Off. The enable line must be turned Off for 10 seconds for the power supply to reset. T106 has a tap to provide current to the optional battery back-up (Part No. 023-3-2000-830). The +26.5V is available at the high current output connector to the power supply and it also powers the +15V, +5V and -5V converters through F102.

6.7.3 SYNCHRONIZING CIRCUITS

The +15V and +5V sections run at the same frequency as the +26.5V pulse width modulator. In order for a beat note not to be produced, a sync circuit is used. If two converters are not synchronized, the difference frequency may show up at an undesired location in the repeater.

Divider R151/R152 samples the output of the main pulse width modulator. When Q116 and Q118 turn on, the output on U104A, pin 3 goes high. C138, R176, CR122 along with U104B creates a very narrow pulse on U104B, pin 6. Q110, Q111 and Q112 level shift and buffer this pulse. When the narrow pulse is presented to the timing capacitor of the +15V and +5V converters, the cycle terminates and a new one starts. This forces the +15V and +5V converters to run at the same frequency and is slightly delayed from the +26.5V converter.

6.7.4 FAN AND THERMAL SHUTDOWN

The voltage supply to the thermal measurement circuit is generated from transformer T101 and the associated bridge rectifier consisting of CR101, CR102, CR110 and CR111 and bulk storage capacitor C101. This voltage is approximately +9V when the AC voltage is at 120V AC.

NOTE: This DC voltage is dependant on the input AC voltage.

U106 provides a very accurate +5V required for proper operation of the temperature sense circuit. A precision temperature sensor (U101) is mounted to the +26.5V rectifier heatsink. The output of this sensor is 10 mV/°C with a ±1% accuracy. This voltage is amplified by U110A with precision resistors R183/R184 setting the gain.

The output of gain stage U110A is fed to the computer interface via WO116 to monitor power supply temperature with the programmer. The output of U110A, pin 3 is also connected to the thermal shutdown circuit U110C, R135, R136, R137, R138 and R139. If the heatsink temperature reaches 92°C (198°F) the output of U110C, pin 8 goes high and saturates Q103. When Q103 is turned on U107 is turned off and the power supply turns off. The remote voltage is always present so when the heatsink temperature drops to 80°C (176°F) the power supply restarts. The high temperature condition would only exist if the fan was blocked or faulty.

The output of U110A, pin 1 also connects to the fan controller. U110D with the associated resistors provides a means to turn the fan on/off. Transistors Q120/Q121 provide current gain and a voltage level shift to run the fan. The fan turns on when the heatsink reaches approximately 45°C (113°F) and turns off again when the temperature reaches 35°C (95°C). In normal operation the fan turns on and off.

6.7.5 +15V CONVERTER

The input voltage to this "Buck" DC/DC converter is the main +26.5V output fused through F102. The bias voltage for the controller IC U112, pin 15 is provided by a +15V regulator U111. The basic buck converter consists of MOSFET Q125, Schottky diode CR126 and storage inductor L102. C165, C166, C167, L103, C169 and C170 filter the output voltage

and attenuate the ripple at the switching frequency (160 kHz). The capacitors are an integral part of the feedback loop. The duty cycle is approximately 60%.

The +15V buck converter is peak current mode controlled. T108 samples the inductor current while MOSFET Q125 is on. The sampled current is translated to a voltage via CR127, R209 and R210.

Because the MOSFET is a high-side switch, a charge pump is required to get the gate voltage above the input voltage. The charge pump operates as follows. When the output from IC U112, pin 14 is low, capacitor C162 is charged through CR124, R198, R199, R200 and Q122/Q123 are off. When U112, pin 14 goes high, the capacitor stays charged and CR124 is reverse biased. Q122/Q123 are turned on forward biasing CR125 and applying a gate-to-source voltage of approximately +12V. During this time Q124 is off. When U112, pin 14 goes low, Q124 turns on and rapidly discharges the gate capacitance.

Resistors R231/R208 coupled with C164 provide snubbing for Schottky diode CR126.

Because the +15V converter operates at greater than 50% duty cycle, slope compensation is required. Capacitor C176 is the time capacitor for this converter and R223 is the resistor that sets the charge current. A sawtooth wave is present on the high side of C176 that is buffered by Q127/Q128. The resistor divider network of R315, R227, R229 and R232 provide the correct amount of compensation for stable operation and current limiting.

The output voltage is sampled by R215, R216 and R217 and sent to the inverting side of the error amplifier internal to the controller IC on U112, pin 1. Voltage loop compensation is set by C174, C175 and R221.

Sync pulse is added into the low side of C176 via C172 and R225. The free running frequency of the 15V converter (approximately 145 kHz) is set about 10% lower than the 26.5V converter. This longer duty cycle allows the sync circuit to synchronize the converter.

Over voltage is sensed using U116 as a reference and amplifier, CR129 acts as a crowbar on the output. Once the crowbar is turned on, opto-isolator U119 is activated to shutdown the power supply. The enable line must be toggled or AC voltage removed for 10 seconds to reset the power supply.

6.7.6 +5V CONVERTER

Operation of the +5V "Buck" DC/DC converter is the same as the +15V, except slop compensation is not required. Some values are different to get the 5.2V DC and current limit to 6A. The duty cycle is approximately 20%.

6.7.7 -5V CONVERTER

The -5V "Buck-Boost" converter scales and inverts the voltage. This converter is free running at approximately 75 kHz. The output switch and controller are built into the 5-leg TO-220 IC U114. L105 is the storage inductor. C204, R270 and R271 close the voltage feedback loop and are set for optimum stable transient response. C208/C209 reduce output ripple. Under-voltage protection is required on this stage and works the same as the over-voltage protection of the +15V and +5V buck converters, but has opposite polarity.

6.7.8 POWER SUPPLY REPAIR AND ALIGNMENT

If a power supply fails it is typically a Power MOSFET or Power Diode. In some cases the MOSFET gate may short and cause some of the driver circuits to be damaged. When replacing heat sunk components it is advisable to replace the sil-pad thermal interface material at the same time. The mounting hardware must be replaced exactly as built in the factory. The mounting screws for the power semiconductors MUST BE torqued to 4-5 in/lbs. Under torque and over torque can shorten the life of the semiconductor.

The majority of the voltage and current limits are set with fixed value components in the power supply. However, the +26.5V, +15V and +5.2V supplies are adjustable. When certain components are replaced, the voltages must be adjusted. The voltages should be set at light load (i.e. repeater in the Receive mode).

1. The +26.5V supply can be adjusted with R174 when any of the following components are replaced: R173, R174, R175, U109, U108, U102, R143, R170 or R171.

2. The +15V supply can be adjusted with R216 when any of the following components are replaced: R215, R216, R217 or U112.

3. The +5.2V supply can be adjusted with R254 when any of the following components are replaced: R253, R254, R255 or U113.

6.8 BATTERY BACK-UP MODULE

6.8.1 OPERATION

When a battery back-up module is installed in a power supply it performs the function of running a repeater in the absence of AC voltage. When AC is present it can be used to charge a pair of lead-acid batteries in series. The charger is a temperature compensated constant voltage charger. The maximum output current from the charger is 2.2A. The charger works when AC is present and the repeater is enabled. The charger switch on the battery back-up module must be "On". The temperature compensation thermal sensor is part of 023-2000-223 battery back-up module cable assembly.

When AC is low or not applied to the 023-2000-800 power supply the battery input takes over if the voltage is within range. The input voltage to the battery back-up module acts as the 26.5V supply and the other voltages in the power supply also are present, +15, +5.2 and -5V. When AC is restored, the battery back-up module disengages automatically. The change over from battery to AC or AC to battery may cause the repeater to reset, depending on battery condition and load status.

NOTE: When using a generator, the DC voltage must be between 23-28.5V (26.5V DC is recommended) and ripple voltage less than 1% or approximately 0.25V P-P.

6.8.2 CHARGER

The charger charges the batteries when the repeater is on and switch S101 is "on". A tap off of the main transformer of the power supply through wire W104 and a +26.5V line via wire W102 are what supply the charger with the necessary voltage to charge the batteries. The tap off of the transformer is biased by the +26.5V and then filtered through L101, C105 and C119. Since the tap from the power supply is not a regulated voltage, bleeder resistors R136/R137 dissipate some power when the batteries are fully charged. No load situation, the peak voltage of the tap is approximately 63V, is not impressed across the 50V capacitors C105/C119. During a battery charging condition the line voltage to the charger on U107, pin 2 should be about 35V.

While charging batteries, if the charge voltage is varied with respect to the temperature of the batteries, the lifetime of the batteries is increased dramatically. Figure 6-9 shows the algorithm used in float charge applications for two 12V lead-acid batteries in series. Figure 6-9 shows that the charge voltage should be 27.3V DC ±0.15V at 25°C (77°F) with -55 mV/°C temperature compensation.

An LM317M linear voltage regulator (U107) is used to create the temperature compensated charge voltage. This device is capable of delivering 2.2A of continuous current to the batteries.

To create a temperature compensated voltage an op amp (U104) is used as a voltage gain device from a temperature probe attached to the batteries (part of 023-2000-223). This op amp with R148/R149 defines the slope for the algorithm of Figure 6-9. The output of the temperature compensation is attached to the adjust pin of U107. R138-R140 allow the output voltage to be set properly at a given ambient temperature. F101 is a 4A resettable fuse used to prevent thermal run away in the event of U107 failure. If the output current to the batteries exceeds 4A this fuse opens. Once the current drops below 100 mA, the fuse closes automatically.

NOTE: If any of the charging components are replaced, R140 needs to be adjusted to set the output (battery back-up battery terminals) voltage to 27.3V ±0.15V when temperature sensor is at 22°C (71.6°F).

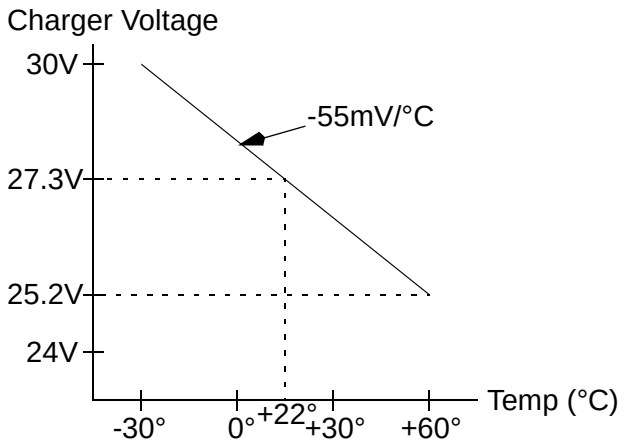


Figure 6-9 NO LOAD CHARGE VOLTAGE vs. TEMPERATURE

6.8.3 REVERSE BATTERY PROTECTION

To obtain reverse battery protection a number of techniques were implemented. Q108/Q110 are arranged in a Darlington configuration to isolate the output capacitors C109-C111 from conducting in the event the batteries are connected backwards. This circuit also provides a means to turn the battery charger off in case the user wants to run the repeater off of another DC source. S101 opens the base of Q105 which turns off Q104. CR111 is a green light emitting diode (LED) located on the right hand side of the battery back-up module when looking at the front of the power supply that tells the user the charger is in charge mode and is marked "On".

To notify the user that the batteries are connected improperly R101/CR101 are connected in series across the batteries. CR101 is a red LED that lights when the batteries are connected backwards and is located on the left hand side of the battery back-up module when looking at the front of the power supply. This LED is marked "Reverse Bat.". CR113 eliminates a path for the reverse battery current through the relay and over/under voltage protection circuitry.

NOTE: Exceeding -30V across the battery back-up terminals with the power supply on will destroy Q105.

6.8.4 ENGAGING THE RELAY

The main purpose of the Battery Back-Up Module (BBM) is that when the power supply loses AC line voltage, a pair of series connected 12V lead acid batteries (approximately 26.4V) or other 23-28.5V DC source will engage to the supply allowing the repeater to operate. To perform this function a voltage comparator (U101) is used to monitor the charge tap coming from the power supply.

A 2.5V reference voltage is supplied to the comparator from U102. The transformer tap voltage is smoothed and divided by CR114, C118, R116, R121 and R122. The values for these components were calculated so that when the AC line voltage is dropped to 70V AC, the output of the comparator turns Q103/ Q102 on which in turn engages the relay K101. The relay is capable of 30A which delivers the battery energy to the power supply via W102 with the return line being W103.

NOTE: When AC is restored, the relay disengages and the charger automatically begins to charge the batteries.

6.8.5 OVER/UNDERVOLTAGE SHUTDOWN

U101 is a quad comparator IC used to create the overvoltage and undervoltage shutdown circuitry. If the batteries are drained sufficiently enough such that the voltage of the batteries drops below 20.3V DC the output of the comparator goes low and turns Q102 off. By turning Q102 off the batteries are switched out of the circuit. The batteries cannot be switched back into the repeater until the voltage rises to 22.6V DC. This operation is in place to protect the repeater and the batteries. In the event the batteries are over charged, or the repeater is driven by the generator that has the voltage set too high, the relay will disengage above 30.5V DC. In order to switch the batteries back to the repeater, the voltage must drop below 29V DC.

In an overvoltage or undervoltage situation, whether AC is present or not, the red LED (CR105) lights until the problem is rectified. This light is located on the right-hand side of the battery back-up module when looking at the front of the power supply and is marked BAT-BAD.

6.8.6 BBM FAN CONTROL

The voltage supply to the thermal measurement circuit is taken from the 26.5V DC line into the BBM. A precision temperature sensor U106 is mounted on the PC board near a screw into the BBM bracket which transfers heat to the sensor. The output of this sensor is 10 mV/°C with a ±1% accuracy. This voltage is amplified by U105 with resistors R153/R154 setting the gain.

The output of this gain stage (pin 1) is fed to another gain stage that performs as a comparator. The output (pin 7) will go high when the heatsink temperature reaches 45°C and will go low when the temperature goes below 35°C. This output is sent to the power supply through Q106 to turn the fan on and off.

6.9 CARD RACK

The card rack provides slots for up to eight logic cards; including Main Processor Card (MPC), Main Audio Card (MAC) and the Interface Alarm Card (IAC). The IAC has a notch in the card to accommodate a pin in Slot-8 so that no other card can be plugged into this slot.

On the back of the card rack is the Backplane with plug-in connectors to the cards and cables to the RF modules, Power Supply and External Connector Board.

Refer to the component layout and schematic diagram in Section 10 for more information on the repeater backplane.

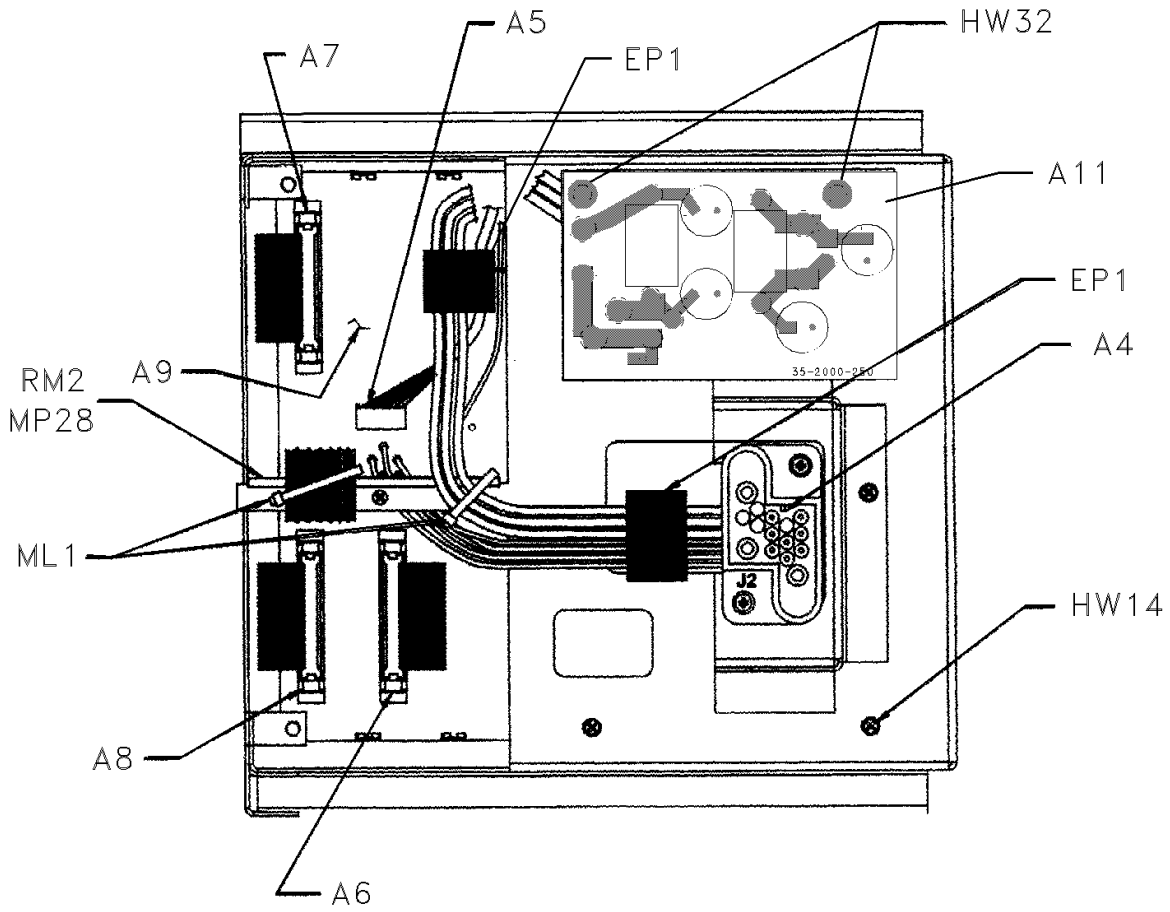


Figure 6-10 BACKPLANE CABLE CONNECTIONS

6.10 EXTERNAL CONNECTOR BOARD

The external connector board (A10) is the interface for the alarm outputs, connecting repeaters through the high speed data bus.

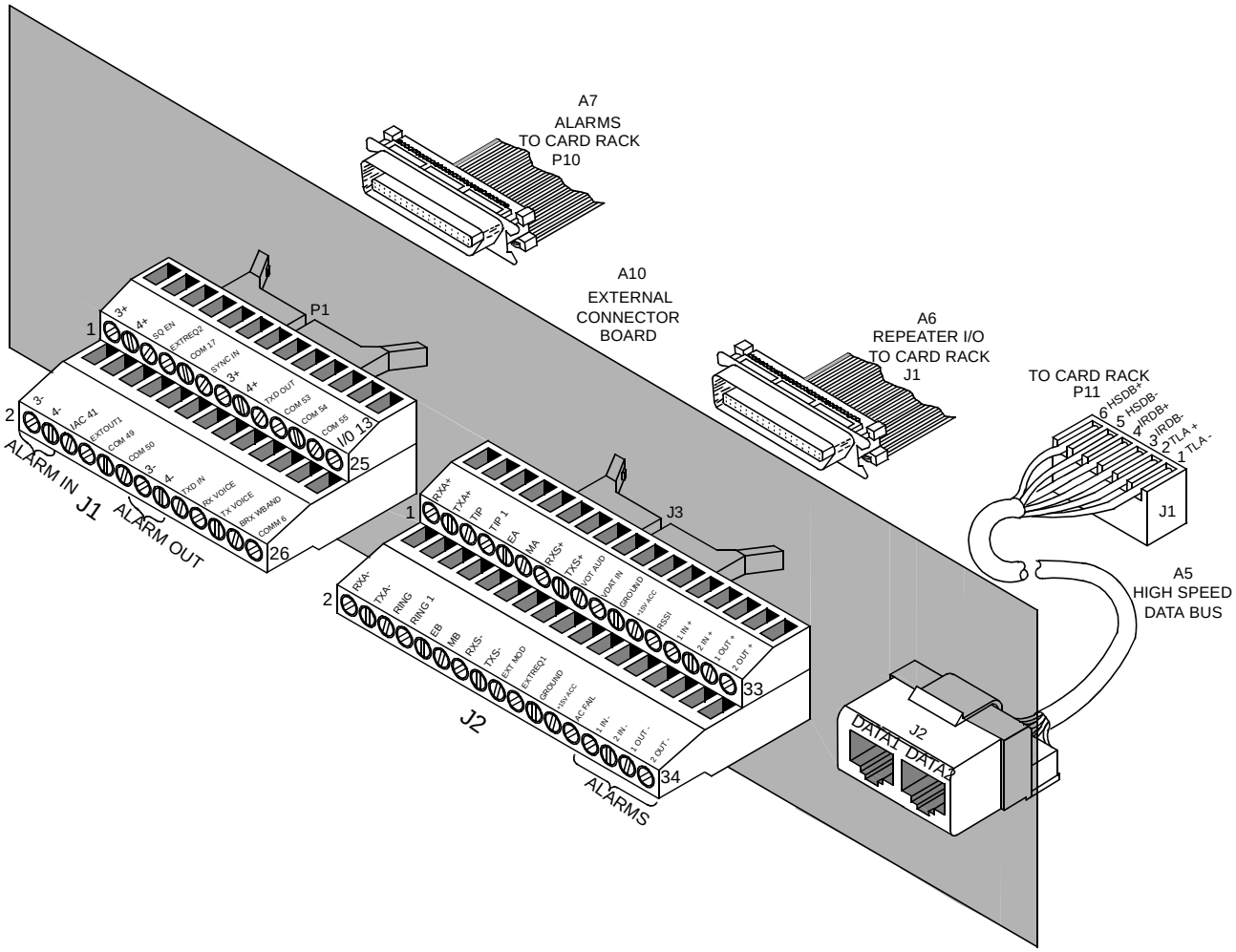


Figure 6-11 EXTERNAL CONNECTOR BOARD

6.11 MAIN PROCESSOR CARD

6.11.1 INTRODUCTION

The Main Processor Card (MPC) connects to the computer with repeater software to program the repeater parameters, sets and reads the alarms, handles communication between repeaters, maintains the audio gating for the MAC, handles initialization requests from cards and contains the repeater RF data for the Receiver, Exciter and CWID.

Control functions for each repeater are performed by the Main Processor in the MPC installed in each repeater. The MPC contains the main software and control over the repeater via microprocessor U27 (see Figure 6-20).

Information is exchanged between repeaters via a High-Speed Data Bus (HSDB) that interconnects all the MPCs. This control technique is called distributive processing and it eliminates the need for a separate system controller at each site. The HSDB processor (U13) on the MPC provides these control functions. The MPC also contains:

- Flash Memory, RAM, non-volatile EEPROM.
- I/O chip select to allow the addressing of data latches for Input/Output.
- Read/Write selection to be sent and received on the Controller Backplane.
- Clock line, data line and chip select line from the IAC to load the Receiver and Exciter synthesizers.
- Serial communication circuitry and processes for the High Speed Data Bus (HSDB).
- Asynchronous parallel communication to the other cards, i.e. alarm input and output circuitry.
- AC Power Failure indication from the IAC.
- Provides an output from the IAC to the power amplifier to control the output power.
- Exciter Logic Push-To-Talk (PTT).
- Receiver synthesizer lock, Exciter synthesizer lock, thermal level from the power amplifier, VSWR level from the PA, forward power level, RSSI signal level, audio levels from the MAC, Receiver and Exciter from the IAC.

6.11.2 MAIN CONTROLLER MICROPROCESSOR (U27)

This contains the main software and control over the repeater (see Figure 6-12).

The main controller (U27) is a VLSI (Very Large Scale Integration) CMOS 16-bit single chip computer with an 8-bit external data bus. This processor has software compatibility with the V20 (8086/8088), faster memory access, superior interrupt processing ability, and enhanced control of internal peripherals. This ROMless processor has a variety of on-chip components including 256 bytes of RAM, serial and parallel inputs/outputs, comparator port lines and timers.

Eight banks of registers are mapped into internal RAM below an additional 256-byte special function register (SFR) area that is used to control on-chip peripherals. Internal RAM and the SFR area are together and can be relocated anywhere in the 1M-byte address space. This maintains compatibility with existing system memory maps.

The two microprocessors and USART (U22) are reset by integrated circuit U17. Reset occurs when power is turned on, when the 5V supply drops below a threshold level or the reset switch (S1) is active.

When a microprocessor is reset, several internal registers are cleared and the program is started over from the beginning. Low-voltage reset prevents improper operation resulting from low-voltage conditions.

When power is turned on, the RESET output U17, pin 6 is initially high and the inverted RESET output U17, pin 5 is initially low. Once the 5V supply stabilizes, these outputs remain in these states for approximately 100 ms to ensure that reset occurs. This time delay is set by capacitor C14 connected to U17, pin 3. If the 5V supply drops below a nominal level, the RESET outputs change states and microprocessor operation is interrupted until the 5V supply returns to normal. C3 prevents fast transients on the 5V supply from causing reset.

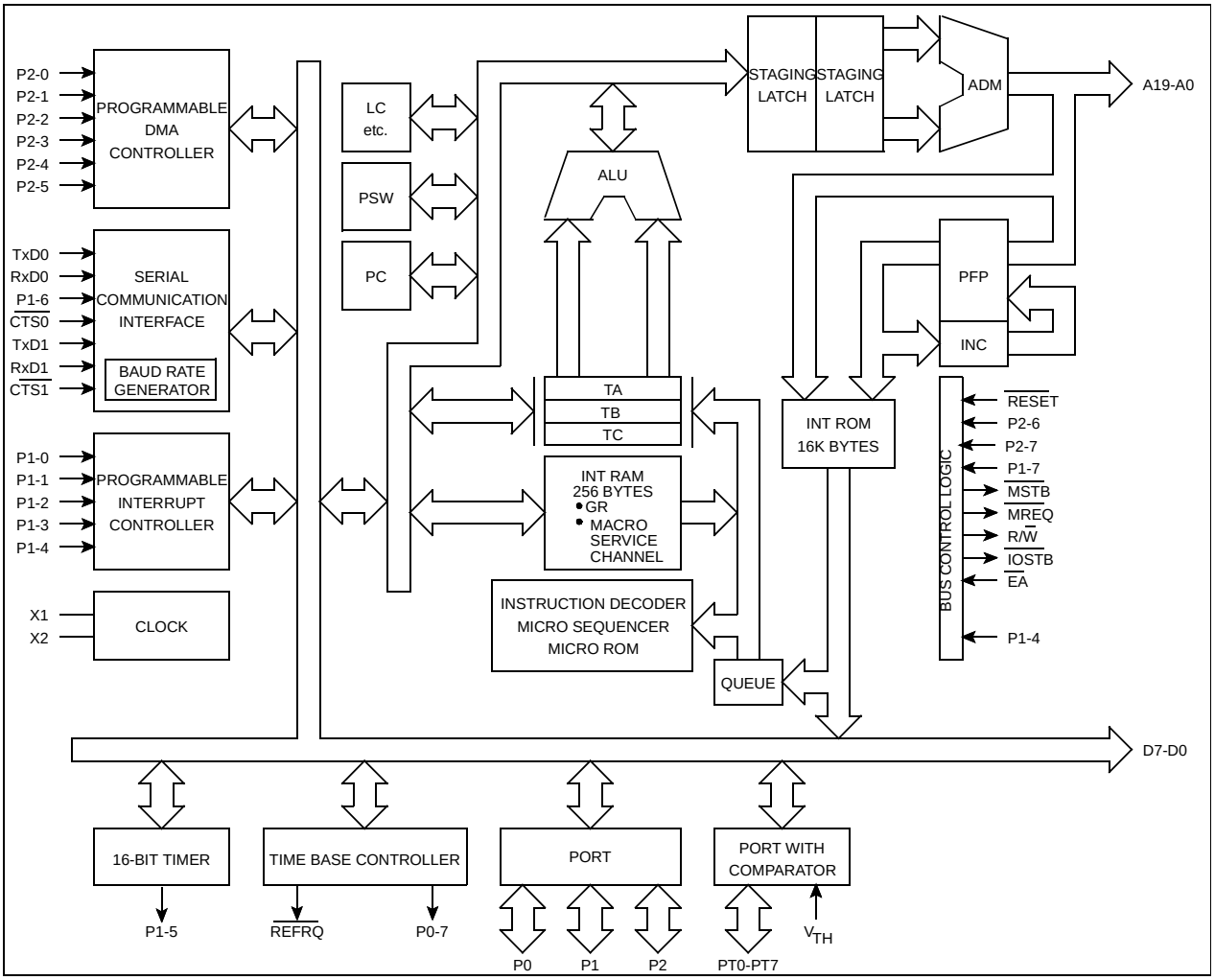


Figure 6-12 U27 BLOCK DIAGRAM

Manual reset can be accomplished by pressing push-button switch S1. When U17, pin 2 goes low, U17 goes into the reset sequence described.

6.11.3 HIGH SPEED DATA BUS MICROPROCESSOR (U13)

The HSDB processor (U13) on the MPC provides the interface with the HSDB. It monitors data on this bus and also transmits data on to this bus when necessary. Information on this bus indicates which repeaters are in use and also which mobiles are using the system. This information is used by the repeater to encode data messages to the mobiles that are monitoring that channel. These messages also include information on which repeater is free and current system priority.

Microprocessor U13 is an 8052 that uses external EPROM (Erasable Programmable Read Only Memory) U14, an 8-bit device that stores the program. The microprocessor uses 2k x 8 EPROM and 64k x 8 RAM. The RAM (Random Access Memory) is used for temporary data storage. The HSDB processor is configured by the Main Processor.

The internal data bus of the microprocessor has four input/output ports. These ports have eight lines each, giving a total of 32 input/output lines. These ports are designated P0, P1, P2, P3. P0 is used as a data bus. Ports P1 and P2 are always used as general purpose inputs/outputs. P3 is used for specialized functions, i.e. a serial port (RxD/TxD) and interrupt (INT).

The operating speed of the microprocessor is set by an 11.059 MHz clock generated by Y2. This clock frequency is divided down by an internal divider to provide a machine cycle time of 1.08 µs. Most program instructions are executed in one machine cycle and none require more than four machine cycles.

The microprocessor U13 communicates with the main processor (U27) through U9 and U10. U9 is a Transmit FIFO (First In First Out) and U10 is a Receive FIFO. This combination makes up an asynchronous parallel-to-parallel interface to the Main Processor.

Microprocessor U13 also calculates the current system priority for the channel. This priority is from the programming software responses and the current priority is sent to the main processor. U13 also reads repeater number and channel number information in memory. U13 also determines the current free repeater and includes that information in the data sent to the Main Processor.

6.11.4 CHIP SELECT DECODERS (U15/U4)

Chip select decoder selects the peripheral chip to read from or write to.

6.11.5 P1 SIGNAL CONNECTOR

The signal interface connector P1 (64 pin) that connects the Address and Data buses and control lines to the backplane connector.

Pins 1-10 ADDRESS BUS
Pins 33-42

This provides a path between the MPC main processor and the external memory on the MPC and the other cards in the Controller. This bus retrieves information programmed into memory for the operation of the repeater.

Pins 11-14 DATA BUS
Pins 43-46

This provides a means of transferring data to and from the CPU on the MPC, memory storage on each card and peripheral devices in and out of the MAC and IAC.

Pin 15 MREQ

A memory request line operates in conjunction with the Read/Write lines. These provide the ability to read from or write to the main processor memory on the MPC.

Pin 16 MSTB

A memory strobe line used during MPC main processor Read/Write operations to external memory on the MPC and other cards plugged into the backplane.

Pin 17-20 UNUSED

Pin 21 LPTT

The Logic Push-To-Talk is an open collector from the Controller. It has a sink capability of 20 mA and a maximum voltage rating of 18V. The transmitter should produce power when this pin is a logic low. Transmit indicator is on the IAC and is controlled independently of the LPTT.

Pin 22 SWITCH (RNT) TX DATA

This is the RS-232 data to the Switch. The CIM receives confirmation of all requests made to the repeater and sends information the repeater receives. The data rate is 1200 baud.

Pin 23 SWITCH (RNT) RX DATA

This is the RS-232 data from the Switch. The CIM controls the repeater with restart, enable and disable, executes requests to read and write to the repeater's memory and tells the repeater transmit code, hang or send turn-off. The data rate is 1200 baud.

Pin 24/56 HSDB+/HSDB-

This interconnects all repeaters to provide an exchange of information. This control technique is called distributive processing and eliminates a separate system controller at each site. Information on this bus indicates which repeaters are in use and also which mobiles are using the system. This information is used by the repeater to encode data messages to the mobiles that are monitoring that channel. These messages also include information on which repeater is free and current system priority.

Pins 25-26 **UNUSED**

Pin 27/59 **-5V IN**

This is the -5V input to the MPC from the power supply via the Controller backplane.

Pins 28-29 **+5V IN**
Pins 60-61

This is the +5V input to the MPC from the power supply via the Controller backplane.

Pins 30/62 **+15V IN**

This is the +15V input to the MPC from the power supply via the Controller backplane.

Pins 31-32 **GROUND**
Pins 63-64

This is the ground connection to the MPC from the power supply via the Controller backplane.

Pin 47 **READ**

Read is used with the MREQ line to read data from the main processor and external memory.

Pin 48 **WRITE**

Write is used with the MREQ line to write data to the main processor and external memory.

Pins 49-55 **UNUSED**
Pins 57-58

6.11.6 J1 COMPUTER CONNECTOR

J1 is the MPC connection to the computer or modem.

Pin 1	Ground
Pin 2	Computer Tx
Pin 3	Computer Rx
Pin 4	Modem DCD

6.11.7 J2 MEMORY SELECT

J2 is jumpered to select either the Flash memory or the EPROM memory. Flash memory is ultra-fast data storage. The normal setting is pin 1 to pin 2.

Pin 1	+12V
Pin 2	U25, pin 1 Vpp
Pin 3	+5V

6.11.8 J3 BAUD RATE

J3 is jumpered to select the baud rate from the computer to the MPC, these two baud rates must be the same (see Figure 6-20). The baud rate of the computer can be found from the command line by requesting /b, /h or /? (see Section 6-20).
To change jumper J13:

Power off the station.
Move P3 to the proper rate.
Power on the station.

6.11.9 S2/S3 HSDB SETTINGS

These switches configure; the HSDB for RS-485 or single-ended 5V operation, indicate if the Summit repeaters are connected to existing repeaters or only Summit repeaters, and if the repeater is an end repeater termination. Refer to Sections 2.9 and 7.5.8.

6.11.10 J4 EPROM MEMORY LOADING

This jumper selects EPROM memory loading for Multi-Net/LTR systems. The Multi-Net/LTR setting is pin 5 to pin 6.

6.11.11 J5 HSDB SPEED

J5 is jumpered to select the data bus speed.
J5, pins 1/2 select the Multi-Speed 11.059 MHz crystal.

6.11.12 J6 WATCHDOG

This jumper enables or disables the watchdog timer for reset. Normal operating mode is P6 jumpering J6, pins 2/3. This jumper should not be moved or removed.

6.12 MAIN AUDIO CARD

6.12.1 INTRODUCTION

This control card stores the information required to operate the routing of audio and data from the inputs of the repeater to the outputs. Data is received on the address bus from the MPC for the operations to perform. The Audio/Data microprocessor and the latches open and close gates to route a path for the audio or data.

Audio control functions for each repeater are performed by the Main Processor in the MPC. The MPC contains the software and maintains control over the repeater via microprocessor U27. The audio/data microprocessor passes received data to the main processor, and it is given the programmable parameters for the gates.

Information is exchanged between the cards in the Controller Backplane via a data bus and an address bus. The address bus provides the link between the main processor and the chip and the address latches on the MAC. These latches control the octal latches that select the audio and data gates. The data bus is the link between the Main Processor and the Audio/Data Processor on the MAC. The Main Processor controls the data to the octal latches and opens and closes the gates required to route audio/data in and out of the repeater. The MAC also contains:

- The audio interface between the receiver and exciter and to the external connections.
- The receive audio filtering with de-emphasis.
- The squelch filter and detector.
- Slow decay timing circuit that controls a mute gate on the main receive audio.
- A filter, DC restoration and slicer circuitry for detecting the subaudible data.
- The fast squelch and data fed to the microprocessor that decodes the data and uses the squelch line as a data qualification signal.
- Transmit audio filter and limiter with pre-emphasis.

6.12.2 AUDIO/DATA MICROPROCESSOR (U111)

This Audio/Data microprocessor is on the MAC card and is used to decode Multi-Net data received from the mobiles. The Multi-Net data is applied to U111, pin 8 (P1.7 input). When a word is successfully decoded the data is then sent to U161 (Tx FIFO) and transmitted on the data bus in parallel to the main processor on the MPC.

When it is time to transmit the CW Identification, the main processor on the MPC sends the identification to U111 via the data bus and U160 (Rx FIFO). The CWID is sent to the Tx Data Amplifier and Filter. The output of the filter is summed with the transmit audio and sent to the Exciter.

U111 also uses six octal latches to provide additional input and output lines. Latch U107/U108 provide outputs which allow U111 to control various audio gates. These gates control the CWID, FSK data, and receive/transmit audio signals.

Latch U106 provides outputs which allow U111 to route signals to the Audio/Data Test Point by switching gates on and off. U106 also provides adjustment of the selected EEPOTs.

U155-U156 allow U111 to select the EEPOT to adjust with chip select lines. These latches also provide routing of some audio/data signals through gates.

U111 also decodes data from the Switch and transmits data to the Switch. In addition, it controls the FSK modem (U110), receive and transmit audio gates, receiver squelch, several front-panel indicators, and other functions.

U111 encodes the data messages transmitted to mobiles monitoring that channel, and controls transmitter keying. The MAC also contains circuitry which provides amplification and filtering of the receive and transmit audio and data signals. In addition, a modem integrated circuit (U110) provides FSK encoding and decoding of data transmitted and received from the Switch.

6.12.3 RECEIVE AUDIO

The Receive Wide Band Audio (RX WBAND) signal from the Receiver is fed into the MAC on P100, pin 27. This audio signal includes; audio, Multi-Net data, and noise. The audio processing circuit provides filtering and amplification of the audio signal before it is routed to the outputs on the MAC card.

A low-pass filter consisting of U121A/B attenuates frequencies above 3 kHz. This removes high-frequency noise from the audio signal. From the filter the signal is fed to amplifier U122A to increase the level before the high-pass filter to preserve adequate hum and noise ratio.

From the audio amplifier the signal is fed to a high-pass filter consisting of U122B/C/D. This filter attenuates frequencies below 300 Hz which removes data present in the wide band audio signal. These filters are configured to act like large inductors. The signal is then fed to U163A which provides 6 dB per octave de-emphasis.

Audio gates U113B/C/D permit noise squelch circuit, control logic, and audio switch to control gating of the audio signal. The control signal from the noise squelch circuit is applied to U113B through U113D. When a carrier is detected, this input is high and U113B passes the signal. Programming determines the gating of audio. When audio is passed by U113B/C and U114A, the audio can be routed through other gates to various outputs (see Section 6.12.6).

6.12.4 RECEIVE SQUELCH CIRCUITRY

The receive wide band audio includes audio, data and noise. The squelch circuit detects this noise to determine receive signal strength. When no carrier or a weak carrier is received, there is a large amount of noise present. Conversely, when a strong carrier is present, there is very little noise present.

U135A is a high-pass filter which attenuates frequencies below approximately 30 kHz so that only high-frequency noise is passed. This noise is amplified by U135B and U123A. A level control adjusts the gain of amplifier U135B. The gain of U123A is partially set by a thermistor to compensate for circuit gain and noise level changes caused by temperature variations.

The amplified noise is then applied to a bridge rectifier. The difference between bridge rectifier outputs is applied to the inputs of U123B. The output of U123B is positive-going pulses. These pulses are applied to U123C which is a Schmitt trigger. When the input signal rises above the reference the output goes low and causes the reference voltage to decrease slightly adding hysteresis to the triggering level. This hysteresis prevents intermittent squelching when the receive signal strength is near the threshold level.

The output of U123C is applied to U123D and Logic Squelch to Audio/Data Gate U159B and audio/data processor U111. Gate U159B routes the squelch output to the Audio/Data Test Point J100. U123D functions as a timing buffer. The output of U123D is applied to Receive Squelch Active Gate U113D. When this gate is closed, the squelch circuit controls Normal Receive Gate U113B to block receive audio if no signal is present.

6.12.5 RECEIVE DATA CIRCUITRY

The receive wide band audio signal is the unfiltered output of discriminator U202 in the Receiver. Therefore, this signal contains audio, Multi-Net data, and noise. A low-pass filter formed by U124A/B attenuates frequencies above 150 Hz by 24 dB per octave so that only the data frequencies are passed. From the filter the signal is fed to amplifier U125A. The gain of U125A is adjusted by a level control. The output of U125A can be routed through Data To Audio/Date Gate U159C and the Audio/Data Test Point J100.

DC restoration circuit converts the data signal from AC floating near ground to a digital signal at levels of 0 and 4.5V. U125B/C provide the reference voltage on the inverting input of comparator U125D. Positive peak detector U125B handles the positive-going peaks of the data signal. Negative peak detector U125C handles the negative-going peaks of the data signal.

The voltage on non-inverting input to U125D is midway between the positive- and negative-going peaks. The data input is on the non-inverting input of U125D. When the data signal rises above the reference voltage, the output goes high. Conversely, when the input voltage drops below the reference voltage, the output goes low. The receive data is then passed to audio/data processor U111.

6.12.6 RECEIVE AUDIO PROCESSING

The receive audio signal from the receiver is fed into the MAC on P100, pin 27. When it is a call that does not need to be routed to the Switch (i.e. most mobile-to-mobile calls utilizing only that repeater), Repeat Gate U153C is enabled and the receive audio signal is routed through Transmit Option Gate U158C to the input of the transmit audio buffer U164B to be retransmitted. Repeat Gate U153C is controlled by processor U111 through latch U107. A logic 1 on the control input causes the signal to be passed, and a logic 0 causes the signal to be blocked.

Amplifier U166A provides amplification of the receive audio signal fed to the Switch. The gain of U166A is set so that if an RF signal is received that has a reference deviation level, the Switch receives a specified level also. No limiting occurs.

When the audio received from the mobile must be routed to the Switch (i.e. calls to a dispatcher or another system), receive audio gate U116B is enabled and passes the signal.

When the received audio must be routed to the backplane (i.e. for other cards), Receive Voice Gate U115B is enabled by processor U111/latch U108 and passes the audio signal to amplifier U120B. Receive To Backplane (RX TO BP) U115C is enabled and passes the amplified audio to the backplane.

When the audio received must be routed to the external speaker or speaker/microphone, Local Audio Mute Gate U114D is enabled by U111/latch U108. The audio is passed to local audio output amplifier U132. The gain of U132 is adjusted by the local audio volume control and the on/off switch.

6.12.7 VOTER AUDIO

When used, the Receive audio from the voter receiver comes into the MAC on P100, pin 25. Amplifier U120A sets the gain of the signal and the output is routed to Voter Audio Mute Gate U115A. The gate is controlled by A/D processor U111/latch U108. If the gate is enabled, the audio goes to the Receive Mute Gate U113C and passes throughout the MAC Card.

6.12.8 COMPANDOR OPTION

The compandor option enhances the receive and transmit audio when used in conjunction with the Telephone Interface Card (TIC) in LTR systems.

The filtered Receive Audio passes through the Receive Mute Gate U113C to the expander input on A301, pin 1. The expand output of A301, pin 2 is coupled to the audio outputs by U114C.

The transmit comes from TX-VOICE P100, pin 32, passes through the TX Voice Gate U158A to the expander input on A301, pin 5. The compressed output of A301, pin 4 is passed to the Transmit Audio Buffer.

6.12.9 TRANSMIT AUDIO

PTT switch (Q101/Q102) provides local microphone Push-To-Talk (PTT) indication to U105. U105 then tells U111 via the data bus that the local microphone PTT has been activated.

U164A amplifies the microphone audio signal to provide the correct input level to U164B. Local Microphone Mute Gate U117C is controlled by A/D processor U111/latch 106. The function of U117C is to mute the local microphone audio when the local microphone PTT switch is pressed. This prevents interference if the microphone remains live when the PTT switch is pressed.

Transmit Intercom Gate U117A is controlled by A/D processor U111/latch U157. When enabled, this gate passes local microphone audio to Main Audio Amplifier U166A and to the Main Audio To Switch output. This provides an intercom between the repeater site and Switch console operator.

Buffer U164B combines the microphone audio signal from U164A with the audio signal from the Repeat Gate U153C.

U127B/C form a high-pass filter that attenuates frequencies below 300 Hz to prevent interference with the Multi-Net data applied at U129B. 6 dB per octave pre-emphasis is provided by an RC combination before the signal is fed to U127D.

Limiter U127D and rectifiers form a precision limiter which prevents over modulation caused by high-level input signals. With normal input levels, the output of a bridge rectifier follows the input of the bridge. When a high-level signal is applied to the bridge, the bridge opens and the output of the bridge is limited to a specific level.

The output of the limiter passes to a composite 6-pole splatter filter formed by U127A, U128D and U128A separated by buffers U128B and U128C.

The output from U128A is fed to Normal Modulation Mute Gate U118B. This gate is controlled by A/D processor U111/latch U106. When enabled, the gate passes transmit audio to EEPOT U149. U149 is an electronically adjustable potentiometer that adjusts the gain of transmit audio amplifier U129C. The gain of U129C can only be adjusted through the software. Therefore, a computer must be attached to the MAC card when levels are set.

The output of U129C is fed to summing amplifier U129B where it is combined with Multi-Net transmit data and CWID when present. The gain of audio and data are the same so unity gain is produced. The output signal is fed to the TCXO where it frequency modulates the transmit signal.

6.12.10 TRANSMIT AUDIO PROCESSING

The balanced audio signal from the Switch is applied to U167A. This stage is a differential amplifier which converts the input signal to a single-ended output. The input impedance is set at 600 ohms. The output signal is applied to Transmit Audio amplifier U167B. The gain of U167B is adjusted by a level control. The output of the amplifier is connected to two gates. One is the Transmit Audio To FSK U116D. This gate is controlled by A/D processor U111/latch U107. When enabled, this gate passes the FSK blank and burst data from the Switch to the Secondary Audio from the Switch converter U131C.

When data and audio share the same path, U131D amplifies the signal and applies it to two gates. When enabled Transmit Secondary To FSK gate U153D passes the audio to FSK Modem U110. The other gate is Data Level Test Gate U133A. When enabled U153A passes the signal to Transmit Option Gate U158C and Level Detect Gate U159A to Audio/Data Test Point J100. The other gate is the Transmit Audio Gate U116C. This gate is also controlled by A/D processor U111/latch U107. When audio from the Switch is to be transmitted, Transmit Audio Gate U116C is enabled and passes the signal and Repeat Gate U153C is disabled interrupting the receive audio signal. When enabled, this gate passes the Main Audio from the Switch to Transmit Option Gate U158C and on to the transmit audio buffer U164B.

Transmit voice from the backplane comes into the MAC on P100, pin 32. When used this signal passes to the transmit voice amplifier U130A. The output level of the amplifier is adjusted by a level control. The output of U130A is applied to another transmit voice amplifier U130B and Transmit Voice Gate U158A. U158A is controlled by A/D processor U111/latch U107. When enabled, the gate passes the voice to Transmit Option Gate U158C and on to the transmit audio buffer U164B. Transmit Voice amplifier U130B is adjusted by a level control. The output is fed to Transmit Net Gate U153B. Gate U153B is controlled by A/D processor U111/latch U155. When enabled, this gate passes transmit voice to the FSK Modem U110.

6.12.11 TRANSMIT DATA AND CWID PROCESSING

The data signal is produced by A/D processor U111 on Transmit Data and Transmit Shape outputs. The transmit shape output is normally the opposite logic level of the transmit data output when data is transmitted. However, the bit before a logic transition occurs, the transmit shape output is the same logic level as the transmit data output. This results in a logic 1 level that is slightly higher and a logic 0 that is slightly lower. This pulse shaping minimizes interference between data bits when the data is filtered by the low-pass filter.

The data from U111 is fed to buffer U126A and Transmit Data Enable Gate U117B. Gate U117B is controlled by A/D processor U111 directly. When enabled this gate passes the data to EEPOT U151. U151 is an electronically adjustable potentiometer that adjusts the gain of transmit audio amplifier U126B. The gain of U126B can only be adjusted through the software. Therefore, a computer must be attached to the MAC card. U126B provides the required signal level at the output of the low-pass filter. A relatively stable DC bias voltage for U126C/D is required

because these stages are DC coupled to the transmit TCXO (see Section 6.2.2) and changes in bias voltage can cause fluctuations in the transmit frequency.

U126C/D form a low-pass filter that attenuates square-wave harmonics in the data signal above 150 Hz to prevent interference with the audio band. From this filter the signal is fed to summing amplifier U129B and combined with the transmit audio signal. The output of U129B is fed to Transmit Modulation Mute Gate U118D. This gate is controlled by A/D processor U111/latch U106. When enabled, transmit audio and data are passed to the Exciter modulation input and the transmit TCXO.

When needed the External Modulation input on P100, pin 11 is fed to External Modulation Mute Gate U118C. Gate U118C is controlled by A/D processor U111/latch U106. When enabled, this gate passes the modulation on pin 11 to the summing amplifier U129B and gate U118D to the modulation input of the Exciter.

The repeater on the lowest frequency channel in each system must periodically transmit the station call letters as a continuous-wave identification encoded by Morse Code. This identification is programmed with the Edit Parameters software.

The CWID output is controlled by A/D processor U111/latch U107. This output is fed to CWID tone generator U100B/A and turns the tone generator on and off to create the Morse Code. From the tone generator the signal is fed to bandpass filter U129A. This filter passes the 800 Hz fundamental present in the signal. The output of the filter is jumpered by P106 on J106, pins 2/3 and P107 on J106, pins 4/5 to the summing amplifier and applied to gate U118D, and to the modulation input of the Exciter.

6.12.12 FSK MODEM

The function of the FSK Modem U109 is to convert digital data into tones that can be sent on a phone line or some other type of audio link. Modem U110 receives tones from the audio link and converts them back to digital data (see Figure 6-13). The FSK Modem is only used when connecting the repeater to an Switch.

This modem is programmed to operate in the Bell 202 Main Loopback mode by the M0-M1 pins. In this mode, a space (logic 0) is represented by a 2200 Hz tone, and a mark (logic 1) is represented by a 1200 Hz tone. The same tones are used for transmit and receive. Therefore, the transmit and receive filters in the modem are set for the same frequency. This form of frequency modulation in which data is encoded by shifting the frequency of tones is called Frequency Shift Keying (FSK). The modulation is phase-continuous which means that no interruption of the waveform occurs when the frequency changes.

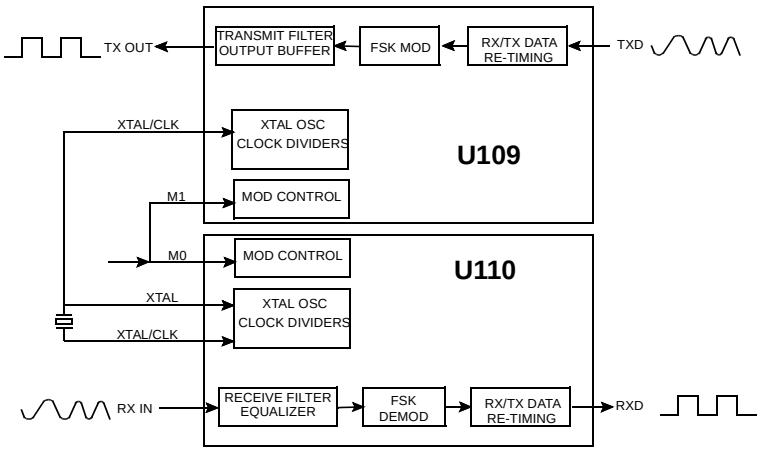


Figure 6-13 MODEM BLOCK DIAGRAM

This modem operates half-duplex, therefore two are used to provide full duplex operation which is the simultaneous transmission and reception of data. The data rate is 1200 baud (bits per second). Full duplex 1200 baud operation is possible because a 4-wire line is used which provides two separate audio paths. The path is selected by programming switches S100 and S101 as shown in Figure 6-17.

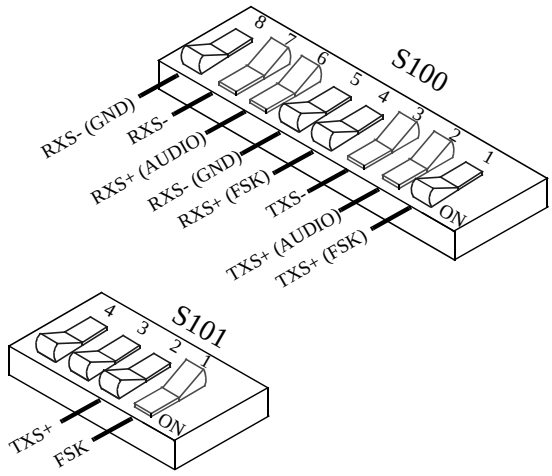


Figure 6-14 FSK MODEM SWITCH SETTINGS

If an RS-232 link is used for data communication with the Switch (on P100, pins 22-23), the modem is not used. This type of data path is selected by programming switches S100 and S101 as shown in Figure 6-18.

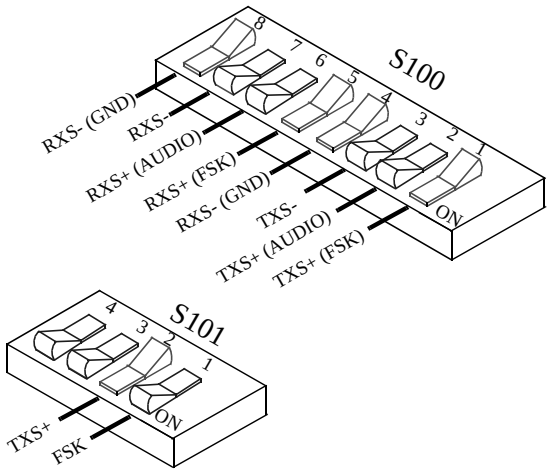


Figure 6-15 RS-232 SWITCH SETTINGS

The level of the transmit FSK signal from U109 to the Switch is set by amplifier U165A. The output of the amplifier is routed to main audio amplifier U166A by FSK To Audio Gate U116A. This gate is controlled by A/D processor U111/latch U108. Buffer amplifier U166B converts the single-ended input to a balanced 600 ohm output.

When the FSK data signal uses a different 4-wire link as the voice signal, the FSK output of U165A is applied to secondary audio amplifier U131A. Buffer amplifier U131B converts the single-ended input to a balanced 600 ohm output.

The FSK signal is also applied to FSK amplifier U165B and fed to gate U115D. Gate U115D is controlled by A/D processor U111/latch U155. When enabled the FSK signal is passed to voice amplifier U120B and Receive Voice To Backplane gate U115C to the Controller Backplane.

The FSK input from the Switch is applied to differential amplifier U131C. This stage converts the balanced input to a single-ended output. The FSK signal is then applied to U131D which sets the input level on the RC input of the modem. When enabled by A/D processor U111/latch U107 the transmit Secondary To FSK gate passes the FSK signal to U110 RC input. When the FSK data signal uses the same 4-wire link as the voice signal, the signal from U167A is applied to transmit audio amplifier U167B and passed by gate U116D to U131C.

If an RS-232 serial data path (1200 baud) is used instead of 600 ohm 4-wire lines, the data signal completely bypasses modem U110. In this case, RS-232 driver U162B converts data to the Switch to RS-232 logic levels of -5V and -7.5V. Conversely, when data is received from the Switch, RS-232 receiver U162C converts the RS-232 logic levels to TTL levels of 0V and +5V.

The 1200 Hz carrier is constantly transmitted by the Switch modem and received by the MAC modem. In turn, the MAC modem sends a constant carrier to the Switch modem. This is used as a constant check that a completed link is established between the two modems. If the carrier does not return from the MAC, it notifies the Switch system operator that the link has been broken.

The input and output connectors for the MAC are defined as follows.

6.12.13 P101 SIGNALING CONNECTOR

The signal interface connector P101 (64 pin) connects the Address and Data buses and control lines to the backplane connector. See Figures 6-21 and 6-22.

Pins 1-10 ADDRESS BUS
Pins 33-42

This provides a path between the MPC main processor and the processor and memory of the MAC. This bus retrieves information programmed into memory for the operation of the MAC.

Pins 11-14 DATA BUS
Pins 43-46

This data bus provides a means of transferring data to and from the processor on the MAC with peripheral devices in the MAC.

Pin 15 MREQ

A memory request line operates in conjunction with the Read/Write lines. These provide the ability to read from or write to the processor memory.

Pin 16 MSTB

The memory strobe line is used for MAC processor Read/Write operations to external memory.

Pin 17-20 UNUSED

Pin 21 LPTT

The Logic Push-To-Talk is not used.

Pin 22 SWITCH (RNT) TX DATA

This is the RS-232 data from the Switch. The CIM controls the repeater with restart, enable and disable, executes requests to read and write to the repeater's memory, and tells the repeater transmit code, hang or send turn-off.

Pin 23 SWITCH (RNT) RX DATA

This is the RS-232 data to the Switch. The CIM receives confirmation of all requests made to the repeater and sends information the repeater receives.

Pins 24/56 HSDB +/-

The High Speed Data Bus interconnects the SUMMIT QX repeaters. A 50 ohm termination is required if SUMMIT QX repeaters are used with existing repeaters and the interface.

Pins 25/57 IRDB +/- (MPC Version 13.03 or later)

This bus is used to communicate Network Management commands to and from Multi-Net repeaters, Simulcast Remote Site Repeaters, and Simulcast Repeater Controllers, that participate in a Network Management System.

Each Network Management repeater site is equipped with one Message Bridge Card (MBC). The MBC serves as the access point or the IRDB for the Network Management Site computer. IRDB message can be targeted to individual repeaters.

IRDB Message Content

Network Management System:
- Alarm Reports
- Configuration Orders

Network Management with Simulcast:
- Alarm Reports
- Configuration Orders
- Simulcast Calibration
- SMC Communication
- Site or Channel Revert Orders

Pin 26 TLA DB

The Trunk Line Accounting Data Bus is used for telephone interconnect calls.

Pin 27/59 -5V IN

This is the -5V input to the MPC from the power supply via the Controller backplane.

Pins 28-29 +5V IN
Pins 60-61

This is the +5V input to the MPC from the power supply via the Controller backplane.

Pins 30/62 +15V IN

This is the +15V input to the MPC from the power supply via the Controller backplane.

Pins 31-32 GROUND
Pins 63-64

This is the ground connection to the MPC from the power supply via the Controller backplane.

Pin 47 READ

Read is used with the MREQ line to read data from the processor and external memory.

Pin 48 WRITE

Write is used with the MREQ line to write data to the processor and external memory.

Pins 49-55 UNUSED

Pin 58 VOTER DATA IN

This is used in a Voter system. Data from the voter site is injected at this pin.

6.12.14 P100 EXTERNAL OUTPUTS

Connector P100 contains the audio and data outputs to the terminal block on the back of the Repeater cabinet. These outputs are connected to other external devices. The input and output connectors for the connector are defined as follows.

Pins 1-6 UNUSED

Pin 7 3.5V

This is the 3.5V DC TCXO reference voltage from the Exciter to the MAC.

Pin 8 TX DATA OUT

This output contains trunking signaling data and CWID data when enabled at jumper J106 and used with external optional equipment.

Pin 9 TX DATA IN

This input would normally contain trunking signaling data, CWID data, and an externally summed in signal. This input is enabled at J106 and is used with external optional equipment.

Pin 10 EXT REQ1

This input provides for external requests from optional equipment.

Pin 11 EXT MOD

This input provides for external wide band modulation of the Exciter with out any filtering. This input is not used at this time.

Pins 13-14 RX AUDIO+/RX AUDIO -

This is the main audio output to the Switch.

Pins 15-16 TX AUDIO+/TX AUDIO -

This is the main audio input from the Switch.

Pins 17-24 UNUSED

Pin 25 VOTER AUDIO

This is the audio input from the voter receivers.

Pin 26 UNUSED

Pin 27 RX WB AUDIO

The Receive Wide Band Audio from the Receiver audio demodulator through the RF Interface Board. The typical amplitude is 387 mV RMS (-6 dBm) and 2V DC with Standard TIA Test Modulation into the receiver.

Pin 28 A D LEVEL

This is the Audio/Data Level output.

Pin 29 TX MOD

The output of this pin is produced by audio and data inputs to the Repeater to produce the signals on this pin. This signal goes through the RFIB and then to the Exciter.

Pin 30 UNUSED

Pin 31 RX VOICE

This is receive audio output connected to the backplane.

Pin 32 TX VOICE

This is transmit audio input connected to the repeat gate.

6.12.15 J100 A D LEVEL TEST POINT

This test point located on the front card edge is used during alignment to monitor audio and data.

6.12.16 J101 SPEAKER/MICROPHONE

This jack is used in conjunction with J102 when a combination speaker/microphone is used during setup and testing of the repeater.

6.12.17 J102 LOCAL MICROPHONE

This jack is used for a microphone to key the Exciter and inject transmit audio.

6.12.18 J103 GROUND

This jack provides a ground connection for the MAC when monitoring the test points.

6.12.19 J104 EXTERNAL SPEAKER

This provides an external speaker connection at the repeater site for monitoring.

6.12.20 J105 WATCH DOG

J105 enables or disables the watchdog timer for reset. Normal operating mode is P105 jumpering J105, pins 2/3. This jumper should not be moved or removed.

6.12.21 J106 TX DATA PATH

Jumpers P106 and P107 connect J106, pins 1-2 and 3-4 for external options that require the Tx Data signal. Normal operation connects J106, pins 2-3 and 4-5.

6.12.22 A301 COMPANDOR CONNECTIONS

EP101	Expand In
EP102	Expand Out
EP103	Ground
EP104	Compress Out
EP105	Compress IN
EP106	+5V

6.13 INTERFACE ALARM CARD

This card utilizes the information required to operate the alarms designated in the programming of the repeater. Data is received on the address bus from the MPC for the; operation to perform, the processor and external memory, open and close relays on the outputs, and receive alarm indications on the inputs. This information is either routed to external devices or alarm outputs can be wired to alarm inputs (see Figure 4-10).

The Interface Alarm Card (IAC) contains 4-input contacts and 4-output contacts. The 4- inputs can be disabled, energized or de-energized. The 4-output relays are dry contacts that have a 2A rating and can be either normally open or normally closed.

The electromechanical relay outputs are comprised of eight SPDT (normally open) relays. The relays are all open at power-on. Data to the relay is latched by a write to the base address.

The IAC activates relays when alarm trigger events occur. The IAC monitors for alarm activity in the system and can set the various output relays as defined by the user during programming. When an external alarm is set it can be monitored from a remote location. Refer to Section 4.3.3 for alarm programming.

6.13.1 RELAY OUTPUTS

The alarm relay outputs are provided via a terminal block on the back of the repeater (see Figures 6-16 and 6-17).

The alarm outputs are on the terminal block at the rear of the repeater.

6.13.2 ISOLATED INPUTS

The isolated alarm inputs are provided via a terminal block on the back of the repeater (see Figures 6-16 and 6-17).

The isolated inputs are driven by either AC or DC signals. The active high inputs can be set by switches to be polarity sensitive, non-polarity sensitive or add a resistance in series to dissipate unused power (see Figure 6-18).

The active low inputs can also be set for either +5V or +15V operation when a ground closure is required to provide an active alarm.

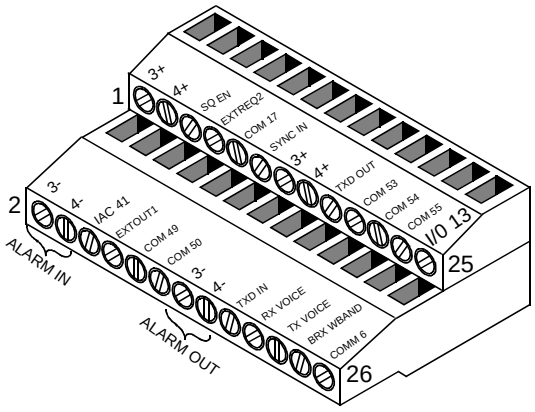


Figure 6-16 4 I/O J1 ALARM OUTPUTS

Standard 12V/24V AC control transformer outputs can be accepted as well as DC voltages. This input voltage range is 5-24V RMS. External resistors connected in series may be used to extend the input voltage range.

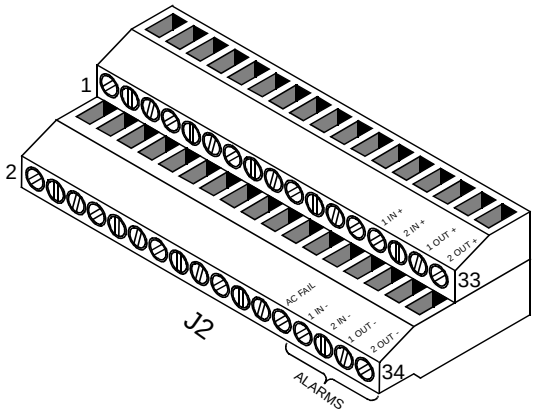


Figure 6-17 4 I/O J2 ALARM OUTPUTS

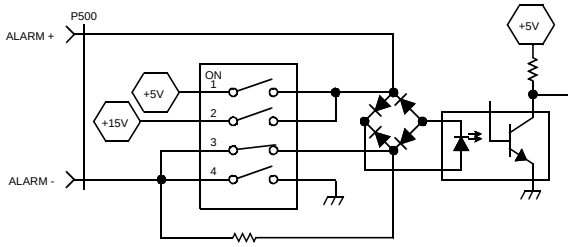


Figure 6-18 S500-S503

6.13.3 ALARM INDICATORS

There are three forms of alarm indicators from the repeater. One form is the two red LEDs and display combination on the MPC. Refer to Table 1-2 for the combinations and definitions of the active alarms.

Another form is the output relay to the terminal blocks at the rear of the repeater where outputs can be wired to external devices or to alarm inputs.

The third form is the output relay and to transmit a 15-character description of the alarm over-the-air to a remote location. The description is sent in Morse code with a transmit ID assigned during programming. A transceiver programmed with this ID can monitor the repeater and alert the system owner when an alarm occurs.

6.13.4 ALARM FUNCTIONS

The alarms can be configured in various modes to alert the system owner to conditions and hazards with the equipment and the repeater site facility. A few of the possibilities are shown in Figure 6-19. In this example the input alarm 2 of Repeater 1 is connected to the door of the building, input alarm 3 of Repeater 5 is connected to the fire alarm system, the AC fail alarm (#16 see Table 1-2) is mapped to alarm 2 output so it can be transmitted (see Figure 4-10) and the output alarm 1 of Repeater 1 is connected to the input alarm 1 of Repeater 2 and so on until the output alarm 1 is fed back to the input alarm 1 of Repeater 1. Then the RF Shutdown alarm (#32) is mapped for alarm 1 in each repeater. This configuration allows Repeater 2 to give an alarm when Repeater 1 has an RF Shutdown alarm output, etc.

The input alarms are given a 15-character description during programming and a Transmit ID. These are used when an input alarm is activated to send a Morse code message consisting of the description over the air to a monitoring transceiver programmed with this ID.

There are 40 internal alarms that can be included in the output alarm configuration (see Table 1-2). These alarms can also be programmed to send an output as shown in the cross reference screen of the alarm configuration menu (see Figure 4-10). Among these alarms are the thermal sense from the PA and the AC fail alarm output on the terminal block at the rear of the repeater to activate the battery backup.

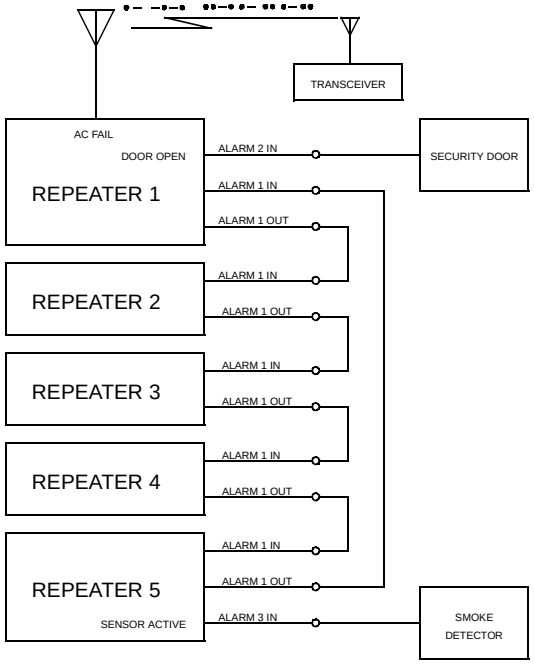


Figure 6-19 ALARM EXAMPLE

6.13.5 P500 SIGNALING CONNECTOR

The input and output connectors for the IAC are defined as follows. The signal interface connector P500 (64 pin) connects the Address and Data buses and control lines to the backplane connector. See Figure 6-23.

Pins 1-4 ADDRESS BUS (A12-A19 Only)
Pins 33-36

This provides a path between the MPC main processor and the latches and multiplexers of the IAC. This bus retrieves information programmed into MPC memory for the operation of the IAC.

Pins 5/37 ALARM 1 IN +/ALARM 1 IN -

This is an input received from a connection to an external device as a specific alert condition.

Pins 6/38 ALARM 2 IN +/ALARM 2 IN -

This is an input received from a connection to an external device as a specific alert condition.

Pins 7/39 ALARM 3 IN +/ALARM 3 IN -

This is an input received from a connection to an external device as a specific condition.

Pins 8/40 ALARM 4 IN +/ALARM 4 IN -

This is an input received from a connection to an external device as a specific alert condition.

Pin 9 SQUELCH ENABLE

This is an output to rear connector J1. It can be configured for inverted output, non-inverted output or logic controlled non-inverted output.

Pin 10 EXTERNAL REQ 2

This is an input received from a connection to an external device.

Pins 11-14 DATA BUS
Pins 43-46

This data bus provides a means of transferring data to and from the latches and multiplexers on the IAC with peripheral devices in the IAC.

Pin 15 MREQ

A memory request line operates in conjunction with the Read/Write lines. These lines read from or write to the MPC processor memory.

Pins 16/17 UNUSED

Pin 18 SYNC IN

This is an input received from a connection to an external device.

Pins 19/51 ALARM 1 OUT +/ALARM 1 OUT -

This is an output to an external device to perform a specific function.

Pins 20/52 ALARM 2 OUT +/ALARM 2 OUT -

This is an output to an external device to perform a specific function.

Pins 21-23 UNUSED

Pins 24/25 +15V ACCESSORY

This DC supply is an output to an external device through rear connector J1.

Pins 26/58 +15V FILTERED

This DC supply is an output to an external device through rear connector J1.

Pins 27/59 -5V IN

This is the -5V input from the power supply via the Controller backplane.

Pins 28-29 +5V IN
Pins 60-61

This is the +5V input to the MPC from the power supply via the Controller backplane.

Pins 30/62 +15V IN

This is the +15V input to the MPC from the power supply via the Controller backplane.

Pins 31-32 GROUND
Pins 63-64

This is the ground connection to the MPC from the power supply via the Controller backplane.

Pins 41-42 UNUSED

Pin 47 READ

Read is used with the MREQ line to read data from the MPC processor and external memory.

Pin 48 WRITE

Write is used with the MREQ line to write data to the MPC processor and external memory.

Pins 49-50 UNUSED

Pins 53-55 UNUSED

Pin 56 THERMAL SENSOR

The Thermal Sensor monitors the PA temperature and creates an alarm condition if the temperature exceeds the limit.

Pin 57 POWER SWITCH

Pin 57 turns the voltage from the power supply to the Repeater on and off. This pin is connected to the on/off toggle switch S508.

6.13.6 P501 EXTERNAL OUTPUTS

Connector P501 contains data and control outputs to the terminal block on the back of the Repeater cabinet. These outputs are connected to the Switch and other external devices.

The input and output connectors for the connector are defined as follows.

Pins 1/17 ALARM 3 OUT +/ALARM 3 OUT -

Pins 2/18 ALARM 4 OUT +/ALARM 4 OUT -

These are outputs to external devices to perform a specific function.

Pin 3 RX WBAND

Receive Wide Band Audio from the Receiver audio demodulator through the RF Interface Board. The typical amplitude is 387 mV RMS (-6 dBm) and 2V DC with Standard TIA Test Modulation into the receiver.

Pins 4-6 UNUSED
Pin 7 EXT OUT 1

This is an external output to rear connector J1.

Pin 8 RF CLOCK

The clock will control the synthesizer chips and power control circuit when loading. This pin is a TTL input from the Controller.

Pin 9 AC FAIL IN

This input from the AC supply is used by the AC fail output to indicate that the AC has been interrupted.

Pin 10 SYN CS RX

This is the main receiver chip select pin for the synthesizer chip. This chip is the same part as used in the Exciter. A low loads the synthesizer.

Pin 11 UNUSED

Pin 12 RF MUX 1 INH

The Multiplexer-1 Inhibit (U105, pin 6) is a CMOS input from the Controller that inhibits (disables) the Multiplexer-1 output with a logic high.

Pin 13 RF MUX 2 INH

The Multiplexer-2 Inhibit (U106, pin 6) is a CMOS input from the Controller that inhibits (disables) the Multiplexer-2 output with a logic high.

Pin 14 RF MUX 3 INH

The Multiplexer-3 Inhibit (U104, pin 6) is a CMOS input from the Controller that inhibits (disables) the output from the RF 3 Multiplexer with a logic high.

Pin 15 PC STR

The Power Control Strobe is normally low until after the power control data is shifted into the power control register. Then the strobe line goes high and back to low. The clock or data lines cannot be changed until after the strobe is set.

Pin 16 HS CS EX

This is the exciter high stability synthesizer chip select. A low enables loading the high stability synthesizer loop. This pin is only used on high stability equipped units.

Pins 19-21 UNUSED

Pin 22 BUF RX WBAND

This is buffered Receive Wide Band Audio from the Receiver audio demodulator through the RF Interface Board. The typical amplitude is 387 mV RMS (-6 dBm) and 5V DC with Standard TIA Test Modulation into the receiver. This is an output to the rear connector J1.

Pin 23 AC FAIL OUT

This is an indication that the AC power has been interrupted.

Pin 24 UNUSED

Pin 25 HS CS RX

This is the receiver high stability synthesizer chip select. A low enables loading the high stability synthesizer loop. This pin is only used on high stability equipped units.

Pin 26 SYN CS EX

Pin 26 is the main Exciter Synthesizer Chip Select that allows input of data to U403 when the line is pulled to logic low.

Pin 27 UNUSED

Pin 28 A D LEVEL

20 lines (of the possible 24) of RF functions sampled are multiplexed to the Controller through this pin using three multiplex chips.

Pin 29 RF DATA A

Data A (U105, pin 11) is the least significant bit (LSB) in the 3 multiplex chips located on the RFIB. This pin is a CMOS input from the Controller requiring a logic high for activation.

Pin 30 RF DATA B

Data B (U105, pin 10) is the middle significant bit in the 3 multiplex chips located on the RFIB. This pin is a CMOS input from the Controller requiring a logic high for activation.

Pin 31 RF DATA C

Data C (U105, pin 9) is the most significant bit (MSB) in the 3 multiplex chips located on the RFIB. This pin is a CMOS input from the Controller requiring a logic high for activation.

Pin 32 RF DATA

This is a data pin with TTL levels from the Controller which has the dual role of loading the synthesizer chips and adjusting the power control D/A lines for proper output power. Up to four synthesizer chips and a shift-register could be connected to this pin.

6.13.7 J500 A D LEVEL TEST POINT

20 lines (of the possible 24) of RF functions sampled are multiplexed to the Controller through this pin using three multiplex chips.

6.13.8 J501 GROUND

J501 is an IAC ground reference for test points.

6.13.9 J502 +15V

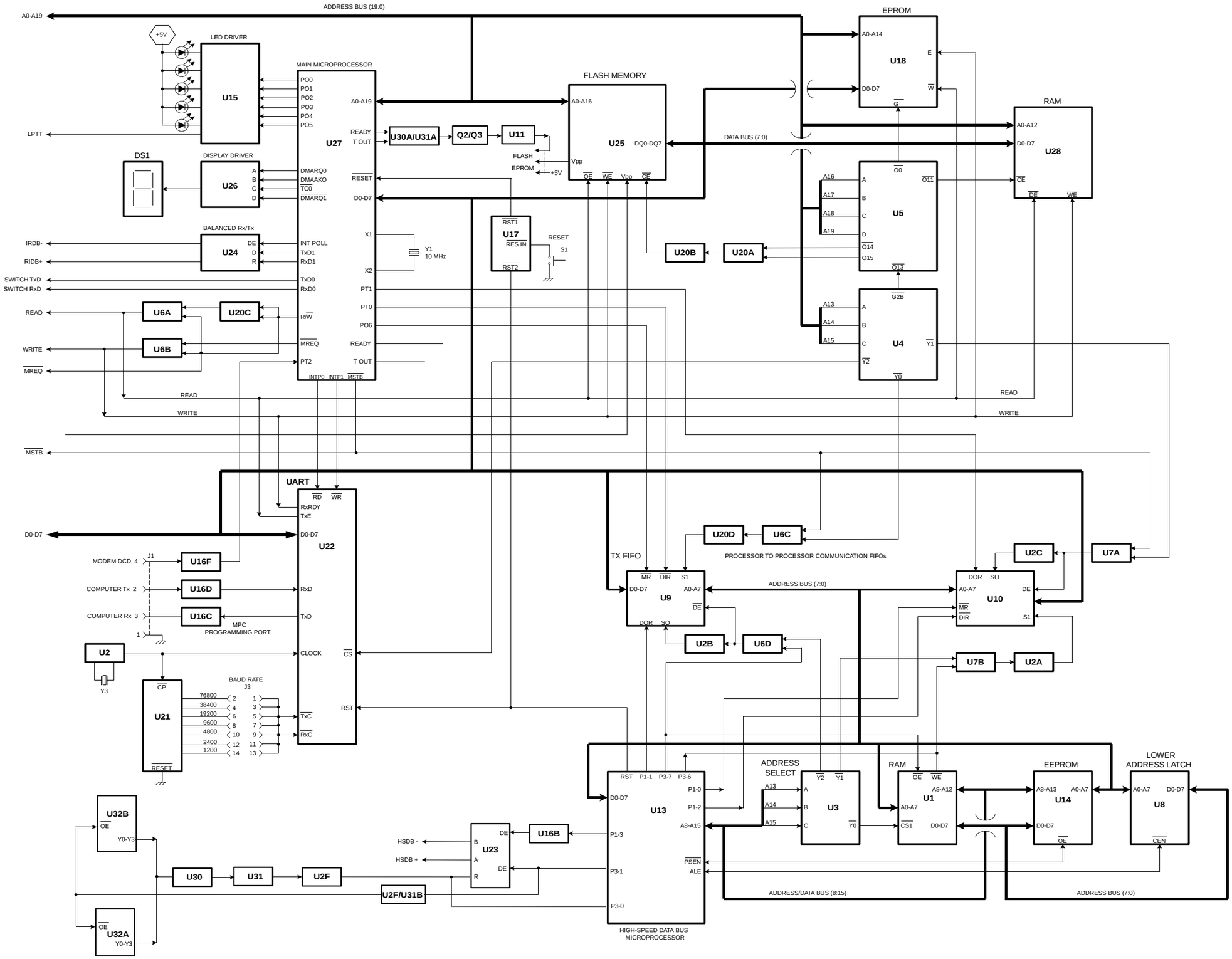
J502 is a voltage test point.

6.13.10 POWER SWITCH

S508 turns the power supply DC voltage on and off from the front of the IAC.

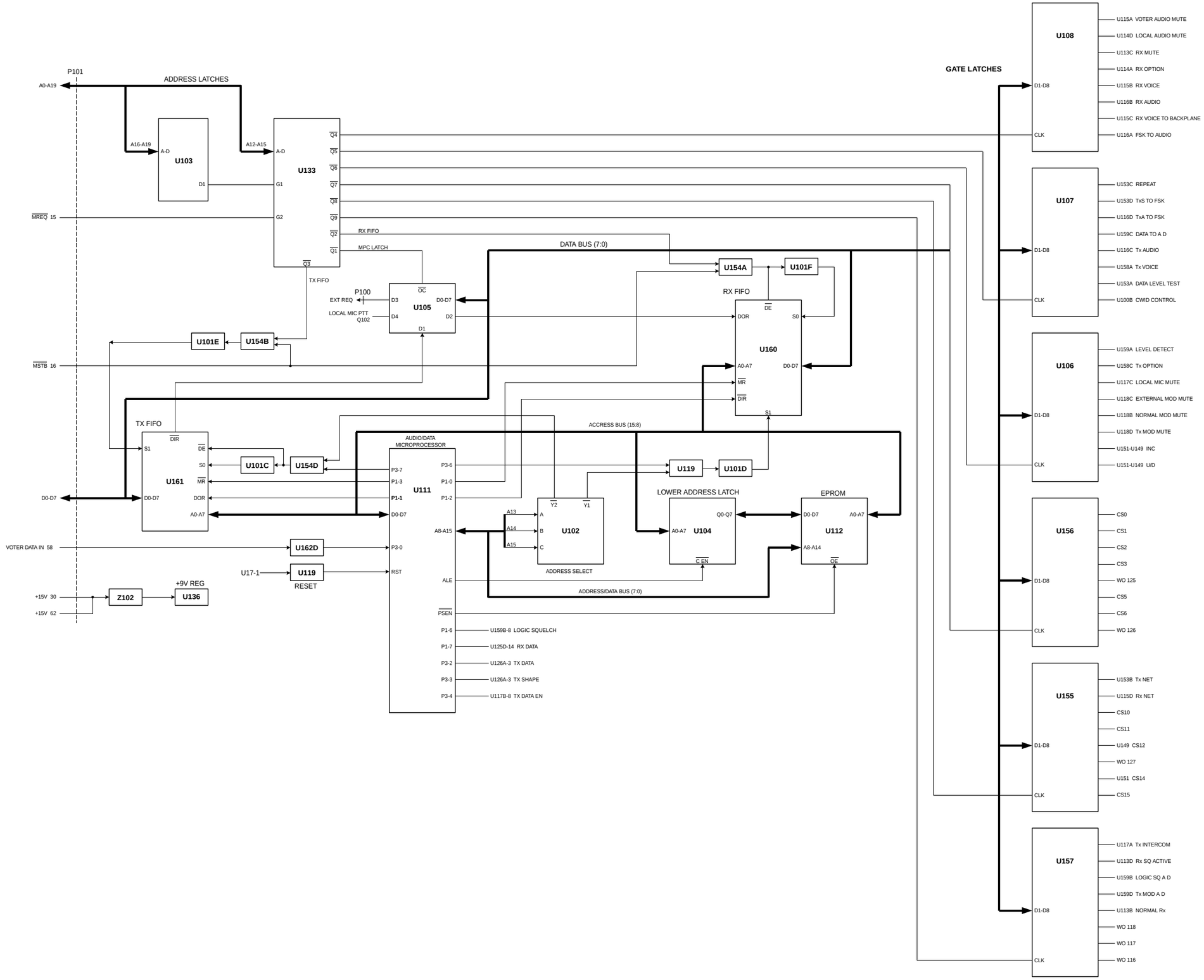
6.13.11 J505 SQUELCH ENABLE OUTPUT

This output can be jumpered by P505 to J505, pins 1/2 to configure the squelch enable output for an inverted output. If P505 jumpers J505, pins 2/3 the output is non- inverted. If P505 jumpers J505, pins 3/4 the output is non-inverted and under the control of U503.

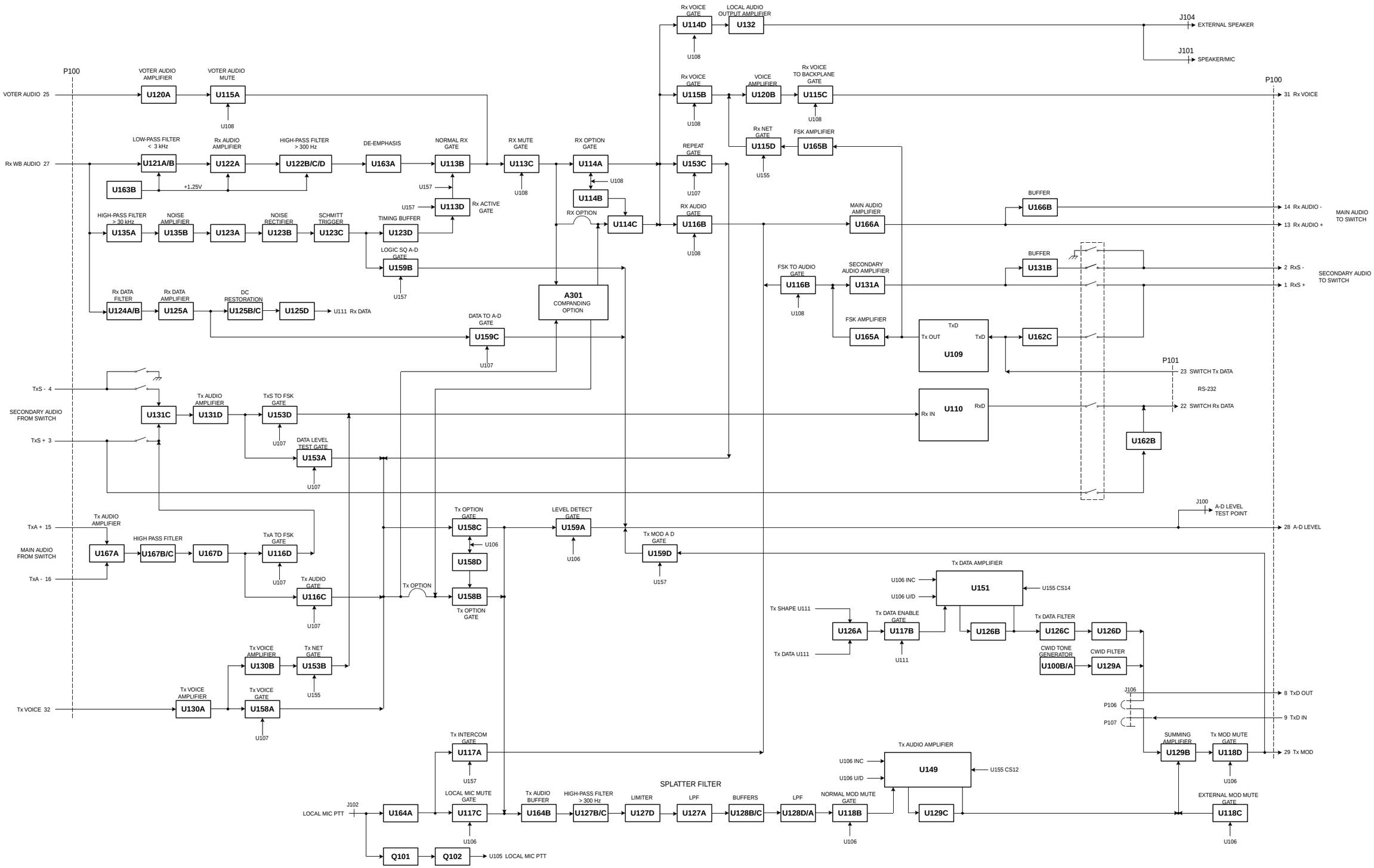


MAIN PROCESSOR BLOCK DIAGRAM
FIGURE 6-20

FOLDOUT



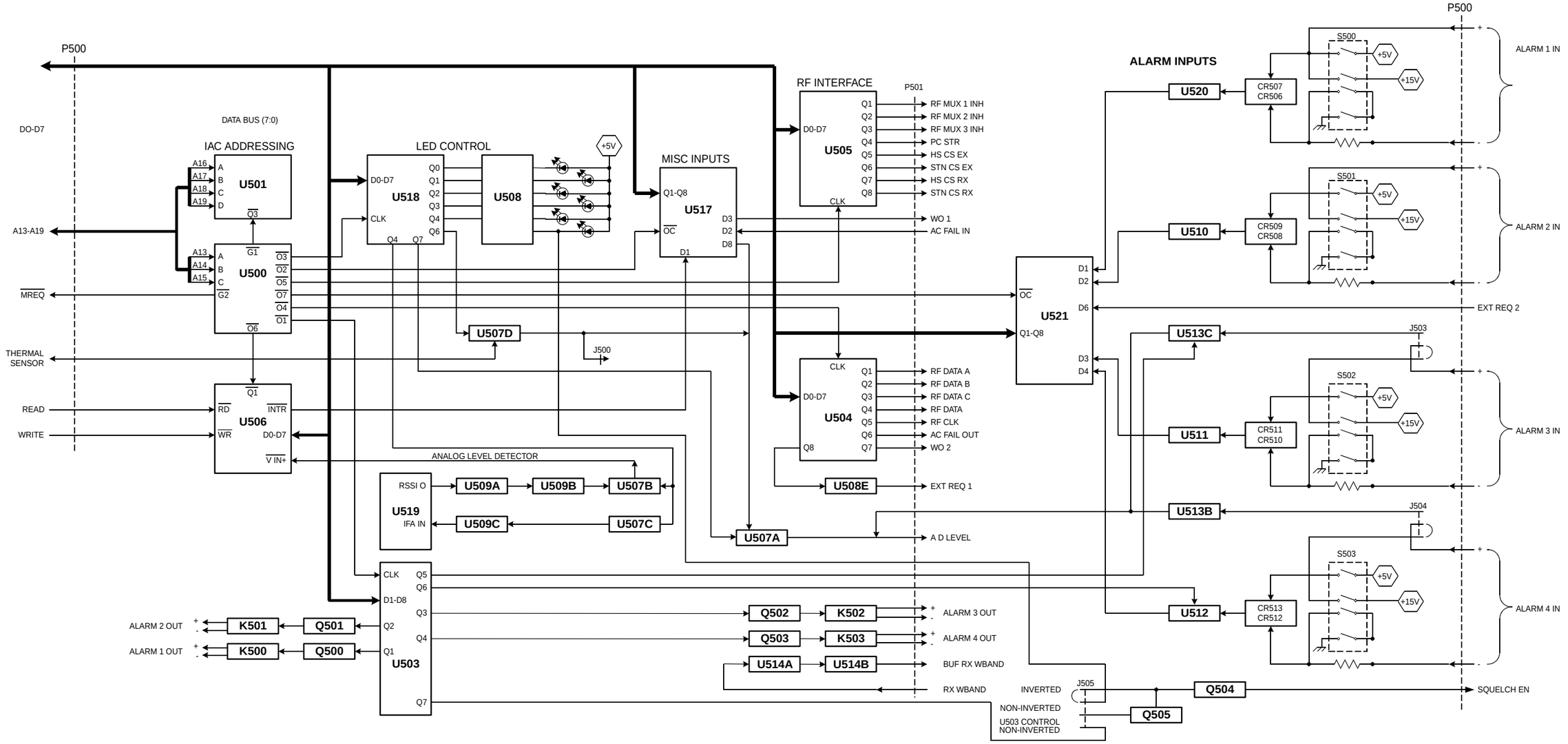
MAIN AUDIO CARD LOGIC BLOCK DIAGRAM
FIGURE 6-21



Month 2000
Part No. 001-2008-104

MAIN AUDIO CARD AUDIO BLOCK DIAGRAM
FIGURE 6-22

FOLDOUT


P500
DO-D7
DATA BUS (7:0)
IAC ADDRESSING
A13-A19
MREQ
THERMAL SENSOR
READ
WRITE
U501
U500
U506
U518
LED CONTROL
U508
+5V
MISC INPUTS
U517
RF INTERFACE
P501
U505
RF MUX 1 INH
RF MUX 2 INH
RF MUX 3 INH
PC STR
HS CS EX
STN CS EX
HS CS RX
STN CS RX
WO 1
AC FAIL IN
U507D
J500
U504
RF DATA A
RF DATA B
RF DATA C
RF DATA
RF CLK
AC FAIL OUT
WO 2
U508E
EXT REQ 1
ANALOG LEVEL DETECTOR
U519
IFA IN
U509A
U509B
U507B
U509C
U507C
U507A
A D LEVEL
U521
U513C
U511
U513B
U512
U520
U510
ALARM INPUTS
CR507
CR506
CR509
CR508
CR511
CR510
CR513
CR512
S500
S501
S502
S503
ALARM 1 IN
ALARM 2 IN
ALARM 3 IN
ALARM 4 IN
J503
J504
J505
EXT REQ 2
SQUELCH EN
U503
ALARM 2 OUT
ALARM 1 OUT
K501
Q501
K500
Q500
Q502
K502
Q503
K503
ALARM 3 OUT
ALARM 4 OUT
U514A
U514B
BUF RX WBAND
RX WBAND
INVERTED
NON-INVERTED
U503 CONTROL NON-INVERTED
Q504
Q505

SECTION 7 ALIGNMENT AND TEST PROCEDURES

7.1 RECEIVER ALIGNMENT

C R I T I C A L A D J U S T M E N T

The TCXO must be adjusted within 5 minutes of turning the AC power on to the repeater. Do not under any circumstances try to set frequency later on in any of the tests, as TCXO frequency stability cannot then be guaranteed.

Refer to Figure 7-1 for component locations. Refer to Figure 7-6 for equipment needed and setup diagram.

7.1.1 PRE-TEST

1. Preset L201, L203, L204, L206, L223 and L224 tuning screws about 1/4 inch above the top of the casting.

2. Preset L202 and L205 tuning screws just barely above the tightening lock nuts.

7.1.2 VOLTAGE MEASUREMENTS

Apply power to the Receiver by plugging the 20-pin cable from the RF Interface Board into J201 (see Figure 7-1).

Measure the voltages at the following pins.

U206, pin 1 - +12V DC ±0.4V
U207, pin 1 - +12V DC ±0.4V
U208, pin 1 - +6V DC ±0.2V
R309/R310 junction - +3.5V DC ±0.1V

7.1.3 PROGRAM TUNE-UP CHANNEL

1. Using the PC and software, program the Synthesizer for the Receive channel number.

2. Tune the VCO helical L220 for +4.5V DC ±0.05V on U209, pin 6 or TP2.

3. Alternately tune L223 and L224 in 1/2-turn to 1-turn increments until a voltage is measured on J201, pin 13 or TP5. At that time, tune L223 for a peak, then L224 for a peak.

4. Retune L223 and L224 for a peak at TP5.

NOTE: The Channel Number, Channel Frequency and Synthesizer Frequency appear at the bottom of the screen.

7.1.4 TCXO FREQUENCY ADJUST

1. Place a pick-up loop (sniffer) or RF probe connected to a frequency counter near L210.

2. Set Y201 (TCXO) for the Injection Frequency ±50 Hz (Inj Freq = chnl freq - 52.95 MHz).

7.1.5 VCO TEST

1. The software programs the synthesizer for 3 MHz **above** the Receive Channel.

2. The voltage on TP2 should be < 7.5V.

3. Record the voltage on J201, pin 13 _____.

4. The software programs the synthesizer for 3 MHz **below** the Receive Channel.

5. The voltage on TP2 should be > 2V.

6. Record the voltage on J201, pin 13 _____.

7. If the voltages recorded in Steps 3 and 6 are not within ±0.2V, tune L224 as required to balance the voltage readings.

8. The software programs the synthesizer for the Receive Channel.

7.1.6 FRONT END ADJUSTMENTS

1. Set the signal generator to the Receive Channel at a level sufficient to produce an output voltage on J201, pin 7 (RSSI Output).

2. Tune L204, L205, L206, L201, L202, L203 and L204 for a peak voltage on J201, pin 7. Decrease the generator output level to maintain a 2-3V reading at J201, pin 7.

3. Set the generator for 100 µV into the receiver with a 1 kHz tone at ±3 kHz deviation (1000 µV at the generator with 20 dB pad gives 100 µV at the receive antenna).

4. Tune Z213 for 2V ±0.05V on TP4.

5. Tune R264 for 387 mV RMS, ±5 mV RMS, on TP4.

6. Repeat Steps 4 and 5.

7. Measure the distortion on TP4.

8. Tune L207, C373, L209, L211, C375 and L225 for minimum distortion <5%, (typically <3%).

9. Repeat Step 8 then Steps 4, 5 and 6.

7.1.7 AUDIO DISTORTION

1. Plug a 16 ohm load at J101 or J104 on the MAC (Main Audio Card).

2. Connect a distortion analyzer to the 16 ohm load.

3. Measure the distortion of the receive audio at J101 or J104 on the MAC with the local volume control set to 2.8V RMS.

4. The reading should be less than 3% (typically less than 1%).

5. Measure receive sensitivity at J101 or J104 on the MAC.

6. The reading should be less than 0.35 µV (typically 0.25 µV).

7. The software programs the synthesizer for 3 MHz **above** the Receive Channel.

8. Receive sensitivity should be less than 0.35 µV (typically less than 0.30 µV).

9. The software programs the synthesizer for 3 MHz **below** the Receive Channel.

10. Receive sensitivity should be less than 0.35 µV (typically less than 0.30 µV).

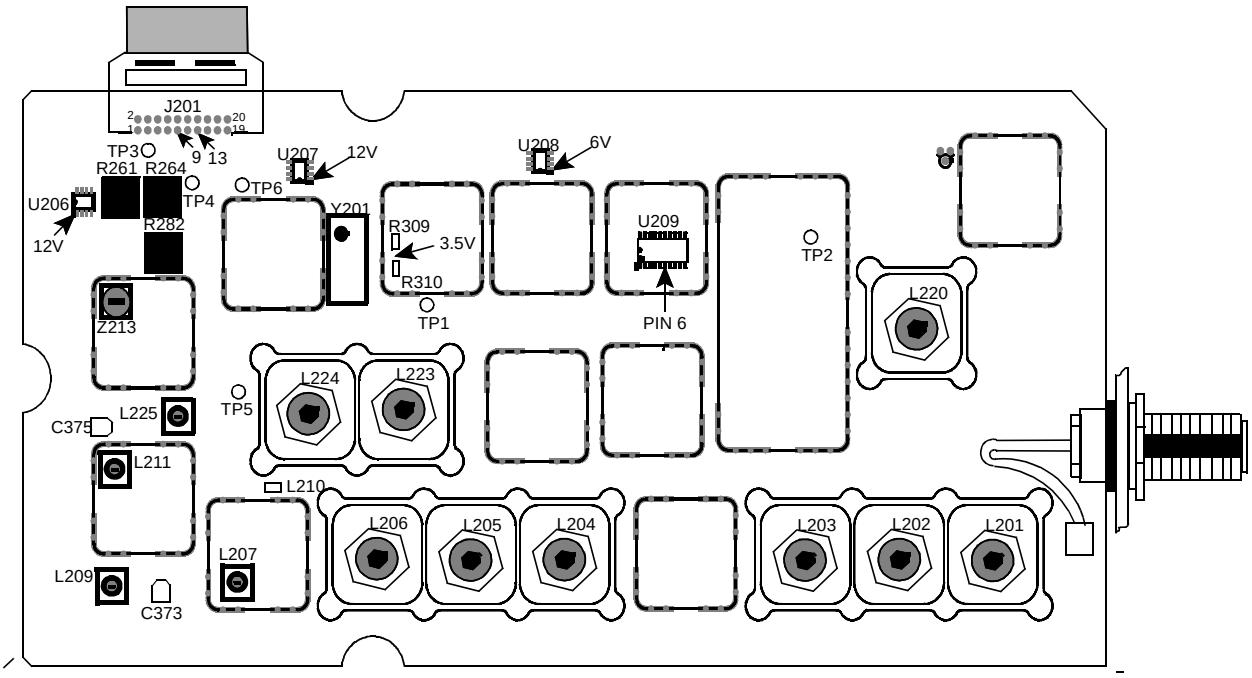


Figure 7-1 RECEIVER ALIGNMENT POINTS

7.2 EXCITER ALIGNMENT

C R I T I C A L A D J U S T M E N T

The TCXO must be adjusted within 5 minutes of turning the AC power on to the repeater. Do not under any circumstances try to set frequency later on in any of the tests, as TCXO frequency stability cannot then be guaranteed.

Refer to Figure 7-2 for component locations. Refer to Figure 7-7 for equipment needed and setup diagram.

NOTE: Some adjustments will be made using the cursor "Up"/"Dn" or "PgUp"/"PgDn" keys.

W A R N I N G

SAFETY MEASURES ARE DISABLED IN TEST MODE. ALARMS ARE ACTIVE. HOWEVER, FEATURES SUCH AS THERMAL SHUTDOWN IN THE PA ARE DISABLED.

7.2.1 PRETEST

1. Set TCXO modulation adjust R425 fully counterclockwise.

2. Connect the power meter to J402.

7.2.2 VOLTAGE MEASUREMENTS

Apply power to the Exciter by plugging the 20-pin cable from the RF Interface Board into J401.

Measure the voltages at the following pins.

U406, pin 1 - +12V DC ±0.4V
U405, pin 1 - +5V DC ±0.2V
U402, pin 1 - +3.5V DC ±0.1V
U404, pin 7 - +3.5V DC ±0.1V

7.2.3 PROGRAM TUNE-UP CHANNEL

1. Program the Tune-Up Channel.

2. Press the space bar to key the Exciter.

3. Tune VCO helical L404 for 4.5V ±0.05V on U403, pin 6.

4. Measure the Power Output of the Exciter at J402. Reading should be +15 dBm ±0.5 dB.

5. Press the space bar to unkey the Exciter.

7.2.4 VCO TEST

1. The software programs the synthesizer for 3 MHz **above** the Tune-Up Channel.

2. Press the space bar to key the Exciter.

3. The voltage on U403, pin 6 should be < 7V. Power output should be +15 dBm ±0.5 dB.

4. Press the space bar to unkey the Exciter.

5. The software programs the synthesizer for 3 MHz **below** the Tune-Up Channel.

6. Press the space bar to key the Exciter.

7. The voltage on U403, pin 6 should be > 2.5V. Power output should be +15 dBm ±0.5 dB.

8. Press the space bar to unkey the Exciter.

9. The software programs the synthesizer for the Transmit Channel.

7.2.5 TCXO FREQUENCY ADJUST

1. Connect a 10 dB pad and frequency counter to J402.

2. Press the space bar to key the Exciter.

3. Tune TCXO Y401 for the Transmit Channel Frequency, ± 50 Hz.

4. Press the space bar to unkey the Exciter.

7.2.6 TRANSMIT MODULATION ADJUST

1. Connect a 10 dB pad and modulation analyzer to J402.

2. Press the "FM" and "3 kHz LPF" switches of the modulation analyzer.

3. Inject a 1 kHz sine wave at 400 mV RMS into P100, pin 32 on the MAC.

4. Adjust U149 with "Up/Dn" and "PgUp/PgDn" keys for 707 mV RMS on P100, pin 29. This waveform should be a "clean" sine wave.

NOTE: This test changes the Tx audio deviation limit. To correct the limit, perform adjustment per Section 7.5.5.

5. Press the space bar to key the Exciter.

6. Set R446 for ±3 kHz deviation.

7. Press the space bar to unkey the Exciter.

8. Adjust U151 with "Up/Dn" and "PgUp/PgDn" keys for a 2V P-P square wave on P100, pin 29.

   NOTE: This test changes the Tx audio deviation limit. To correct the limit, perform adjustment per Section 7.5.5.

9. Press the space bar to key the Exciter.

10. Set R425 for "best" square wave as observed on the modulation analyzer output to the oscilloscope.

NOTE: Ensure that the oscilloscope is "DC" coupled and the Modulation Analyzer has the 3 kHz LPF switch set but NOT the 300 Hz HPF and 50 Hz HPF switches set.

11. Press the space bar to unkey the Exciter.

12. Connect a 10 dB pad and modulation analyzer to J402.

13. Press the "FM" and 3 kHz LPF switches of the modulation analyzer.

14. Inject a 1 kHz sine wave with a level of 400 mV RMS into P100, pin 32.

15. Adjust U149 for 707 mV RMS on P100, pin 29. This waveform should be a clean sine wave.

16. Press the spacebar to key the Exciter.

17. Set R446 for ±3 kHz deviation (very little adjustment should be needed).

18. Press the spacebar to unkey the Exciter.

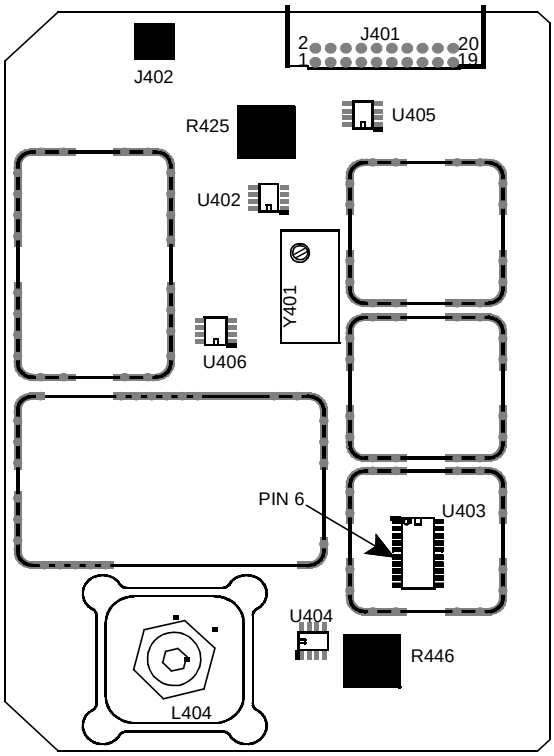


Figure 7-2 EXCITER ALIGNMENT POINTS

7.3 75W POWER AMPLIFIER ALIGNMENT

7.3.1 INTRODUCTION

Refer to Figure 7-3 and 7-5 for component locations. Refer to Figure 7-8 for equipment needed and setup diagram.

Select "PA" from the "TEST" menu in the Repeater Programming Software.

I M P O R T A N T N O T E

No field alignment is required. Adjustments in Sections 7.3.2 and 7.3.3 are part of a new unit production test procedures. They should only be performed as required on "out-of-warranty" and "field-repaired" units. Broken seals on R116, R663 or R680 will void the warranty! Full power control range of 25-75W is controlled by the repeater configuration parameters under the Edit-Setup Parameters menu selection.

The adjustments in Section *7.3.2* provide for proper matching for the output of Q501 and set a protective limit on the drive to the final transistors. This limit is approached only under certain unusual operating or repair conditions. However, improper adjustment may impair normal operation of the PA, especially at temperature extremes.

If Q501 or U501 are replaced, only Section *7.3.2* adjustments should be performed. No other adjustments are necessary in this case. Replacement of RF components surrounding Q501 or U501 does not justify performing Section 7.3.2 adjustments. Replacement of active components within the power control circuitry of the RF Interface Board would require Section 7.3.2 adjustments.

These adjustments are necessary **only** if repairs are made and such repairs are likely to affect the sensitivity/calibration of the forward or reverse power detectors (e.g. replacement of detector diodes CR651/ CR652 or of the entire forward/reverse power detector assembly). Replacement of components within the power control circuitry of the RF Interface Board are unlikely to affect the calibration of the power control.

NOTE: Replacement of Q501, Q502, Q503 or U501 does <u>not</u> require the adjustments in this Section.

7.3.2 DRIVER TUNING AND LIMIT ADJUSTMENTS

1. Connect attenuator and power meter to J501.

2. Connect the:
   Power supply ground lead to P105
   +15V DC lead to P103
   +26.5V DC lead to P101
   36-pin cable to J101 on the RFIB.

3. Set the signal generator to +15 dBm ±0.1 dB at 870 MHz. Connect the signal generator to A9.

4. Press the space bar to key the PA.

5. Set R116 on the RFIB for 22W ±1W (±0.2 dB).

NOTE: Required measurement accuracy precludes the use of most "shop-quality" wattmeters for this Section. Cable and attenuator losses must be taken into account.

6. Tune C521 for maximum power.

7. Reset R116 for 22W ±1W (±0.2 dB).

8. Repeak C521.

9. Press the space bar to unkey the PA.

C R I T I C A L A D J U S T M E N T S

NOTE: Improper adjustment may impair normal PA operation.

10. Set the generator to +15 dBm ±0.1 dB at 860 MHz.

11. Press the space bar to key the PA.

12. Adjust R116 for 40W ±2W (±0.2 dB).

13. Press the space bar to unkey the PA.

14. Set the generator to +15 dBm ±0.1 dB at 850 MHz.

15. Press the space bar to key the PA.

16. Adjust R116 for 40W ±2W (±0.2 dB) only if the power exceeds 40W.

17. Press the space bar to unkey the PA.

18. Remove +26.5V DC from P101. (This eliminates possible damage if the coax ground is accidentally shorted to a live collector inductor.)

19. Disconnect the attenuator and power meter from J501 and connect to Transmit Antenna Connector A8.

20. Connect cable A501 to J501. Ensure the cable position is midway between the drive collector feed and the adjacent input Wilkinson combiner traces on the printed circuit board.

7.3.3 REFLECTED POWER ADJUST

1. Remove the load cable from A8.

2. Press the space bar to key the PA.

   NOTE: This will not harm the PA.

3. Adjust Reverse Power Calibration Pot R680 for equal voltages on W126 and W121 on the RFIB or for equal Forward and Reverse Power.

4. Press the space bar to unkey the PA.

5. Apply "Glyptol" to R663, R680 and R116.

6. Momentarily short R171 on the RFIB. The PA fan should turn ON.

7. Measure temperature detector voltage at W127 on the RFIB. Normal output at 25°C ambient is approximately +2.1V DC.

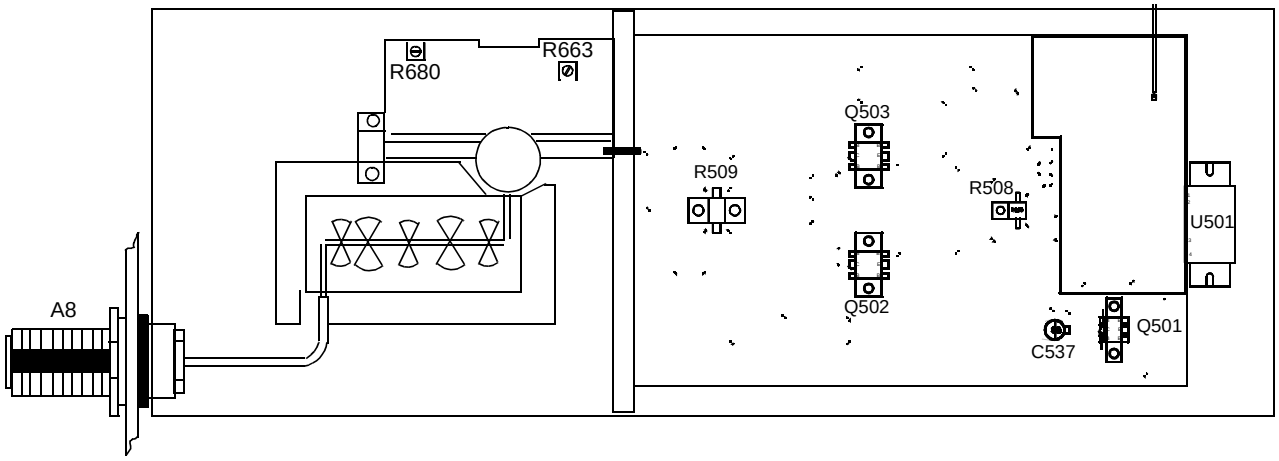


Figure 7-3 75W POWER AMPLIFIER ALIGNMENT POINTS

7.4 175W POWER AMPLIFIER ALIGNMENT

Refer to Figures 7-4 and 7-5 for component locations. Refer to Figure 7-6 for equipment needed and setup diagram.

NOTE: No alignment is required unless the driver transistor Q502 or driver matching caps have been replaced or critical components on the power detector board have been replaced.

WARNING

Breaking the glyptol on R663, R680 or R76 will void the warranty on the PA.

7.4.1 PRETEST

Refer to Figure 7-6 for test circuit and equipment needed.

1. Connect the:
   Power supply ground lead to P105
   +15V DC lead to P103
   +26.5V DC lead to P101
   36-pin cable to J101 on the RFIB

2. Connect attenuator and power meter to A8, the Transmit Antenna Connector.

3. Set R663 on the Forward/Reverse Power Detect board fully counterclockwise.

4. Set R76 on the RFIB fully counterclockwise.

5. Run PC software: Test/PA.

6. Set the generator to +15 dBm ±0.1 dB at 860 MHz.

7.4.2 POWER INPUT ADJUST

NOTE: Required power measurement accuracy precludes the use of most "shop quality" wattmeters. Cable and attenuator loss must be taken into account.

C R I T I C A L A D J U S T M E N T S

1. Press the space bar to key the PA.

2. Adjust Forward Power Calibration Pot R663 for 175W ±0.1 dB (±4W).

3. Press the space bar to unkey the PA.

4. Check that Power Out at 850 MHz and 870 MHz is within 0.25 dB (±10W) of the Power Out at 860 MHz.

5. Verify that Output 1 is within 20% of Output 2 and that Output 3 is within 20% of Output 4.

6. Press the space bar to unkey the PA.

7.4.3 PRE-DRIVER POWER LIMIT ADJUSTMENT

1. Press the space bar to key the PA.

2. Set a power reference of 0 dB at 175W. While monitoring the Transmit current and RF output level, use the Up arrow key to increase the power level until 1 dB above 175W (220W) is reached.

CAUTION

If TX current begins to increase rapidly and is not constant with time, then unkey the PA immediately and troubleshoot.

3. Adjust power limit control R76 clockwise until power is limited to 0.75 dB above 175W (208W).

4. Press the space bar to unkey the PA.

NOTE: Full power (175W) is controlled by the repeater configuration parameters under the Edit-Setup Parameters menu selection.

7.4.4 REFLECTED POWER ADJUST

1. Remove the load cable from A8.

2. Press the space bar to key the PA. This will not harm the PA.

3. Adjust Reverse Power Calibration Pot R680 for equal voltages on W126 and W121 on the RFIB or for equal Forward and Reverse Power.

4. Press the space bar to unkey the PA.

5. Apply glyptol to R663, R680 and R76.

6. Press FN4 to turn on/off fans. Both PA fans should turn On.

7. Measure temperature detector voltage at W127 on the RFIB. Normal output at 25°C ambient is approximately +1V DC.

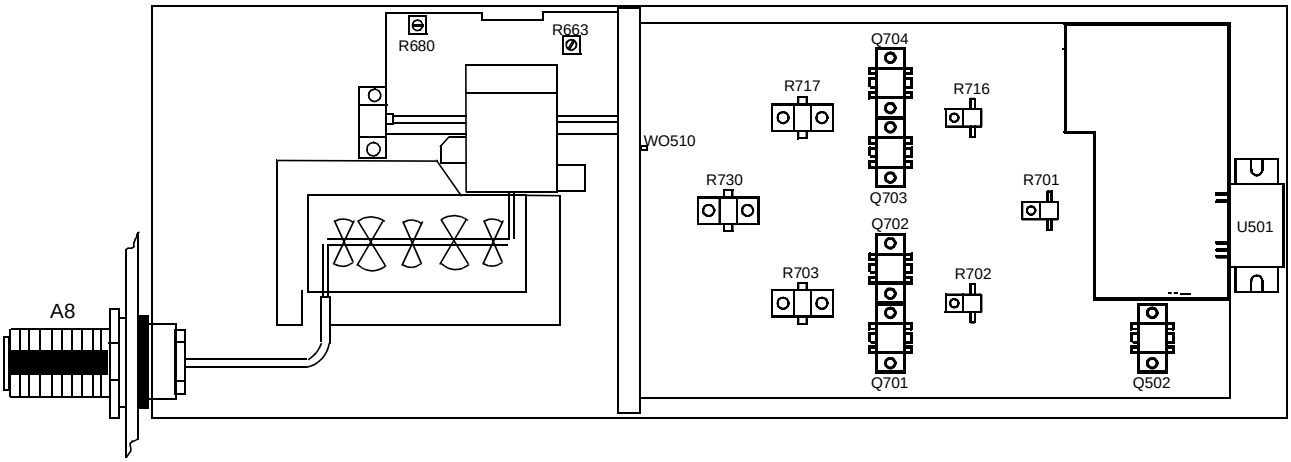


Figure 7-4 175W POWER AMPLIFIER ALIGNMENT POINTS

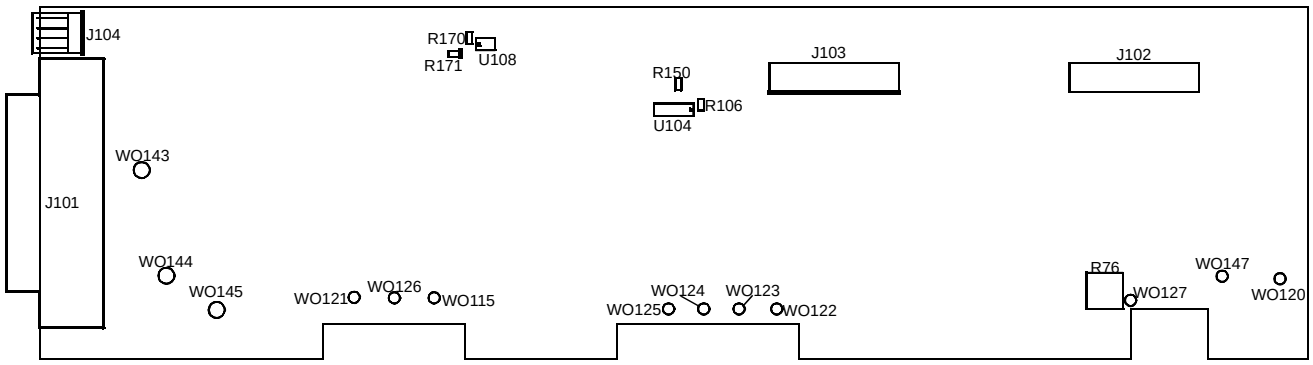


Figure 7-5 RF INTERFACE BOARD ALIGNMENT POINTS

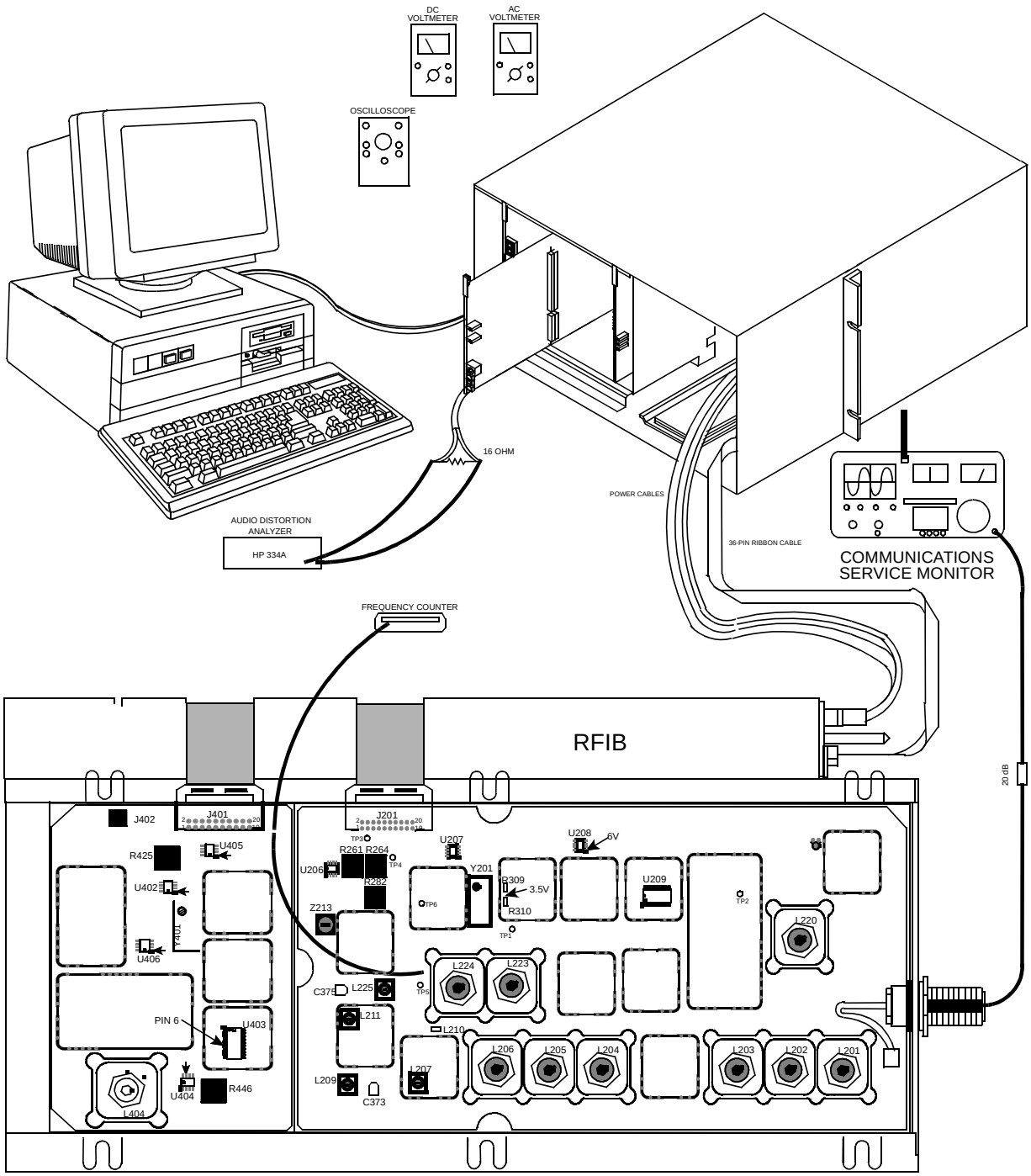


Figure 7-6 RECEIVER TEST SETUP

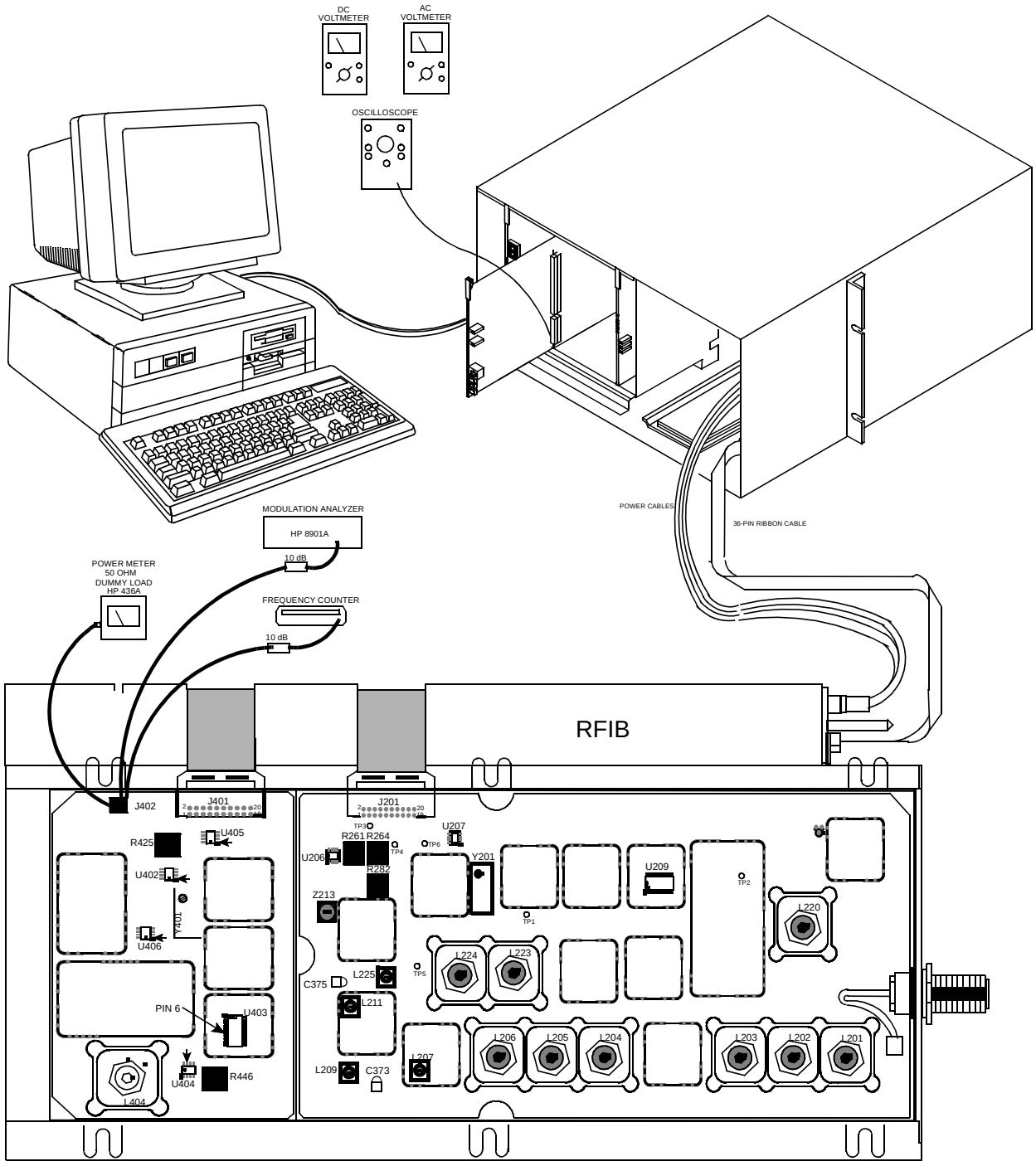


Figure 7-7 EXCITER TEST SETUP

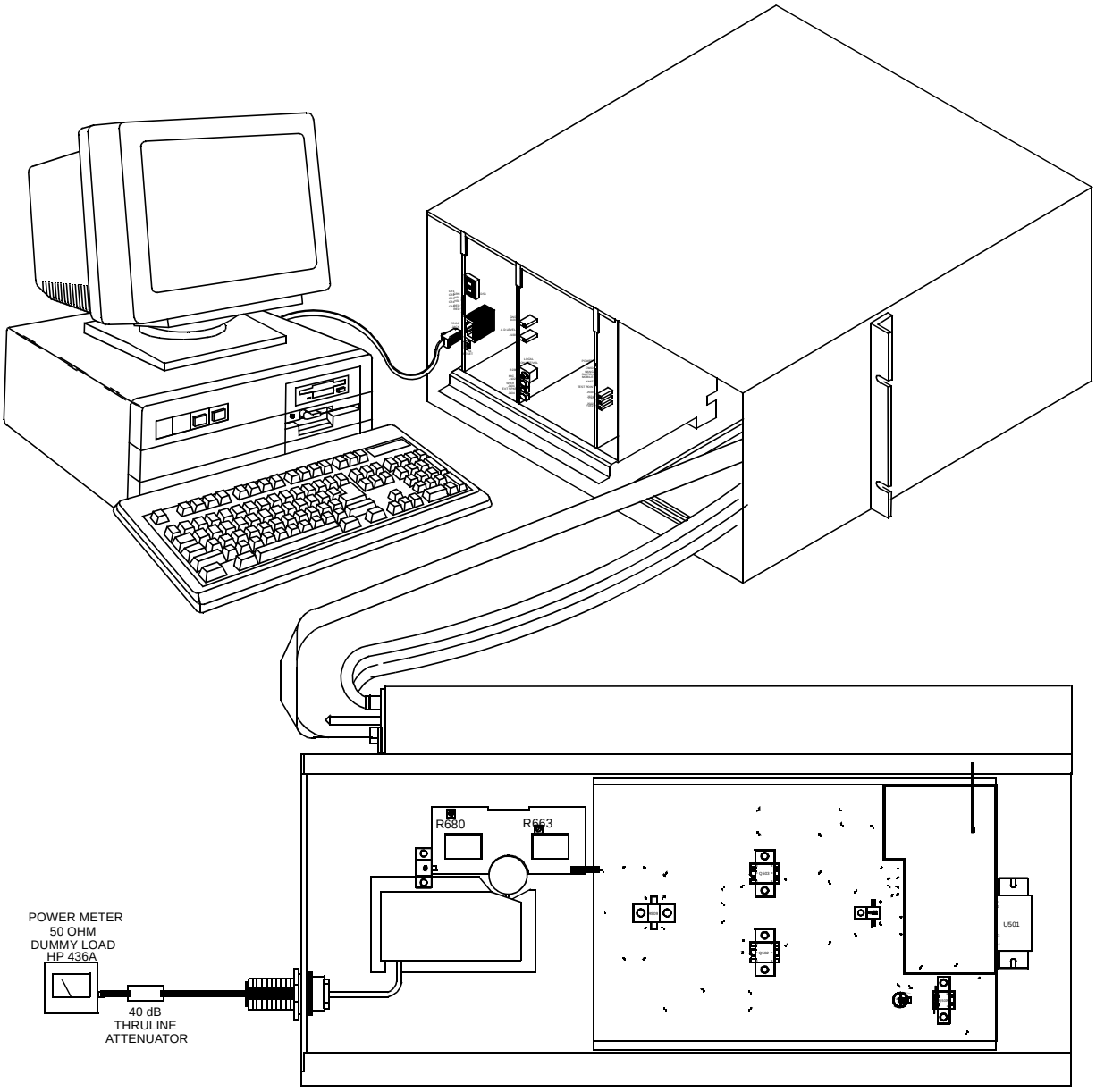


Figure 7-8 75W POWER AMPLIFIER TEST SETUP

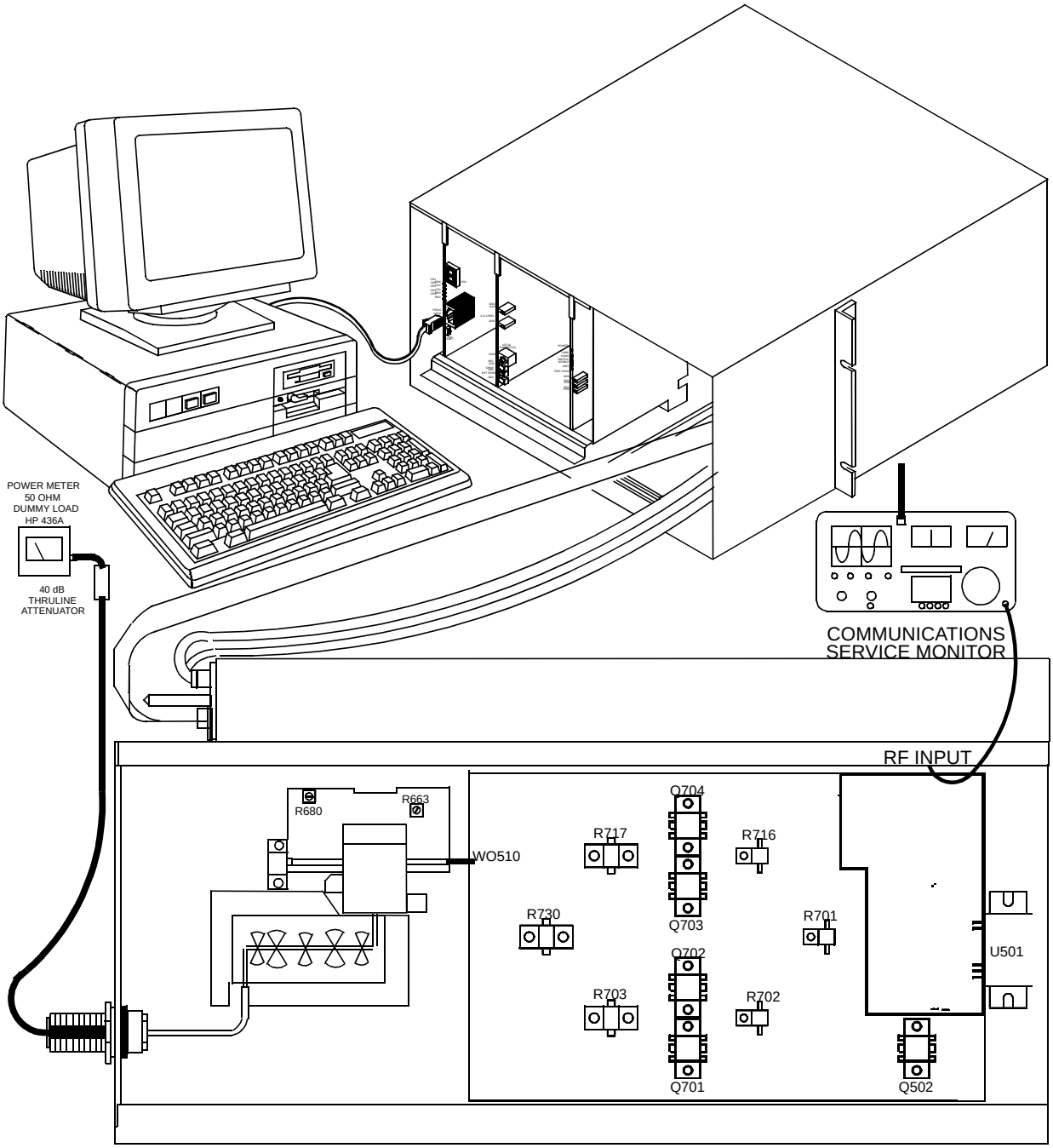


Figure 7-9 175W POWER AMPLIFIER TEST SETUP

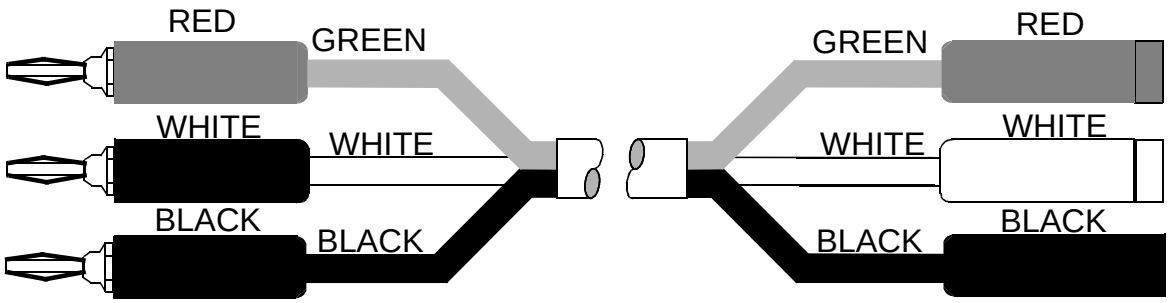


Figure 7-10 POWER EXTENDER CABLES

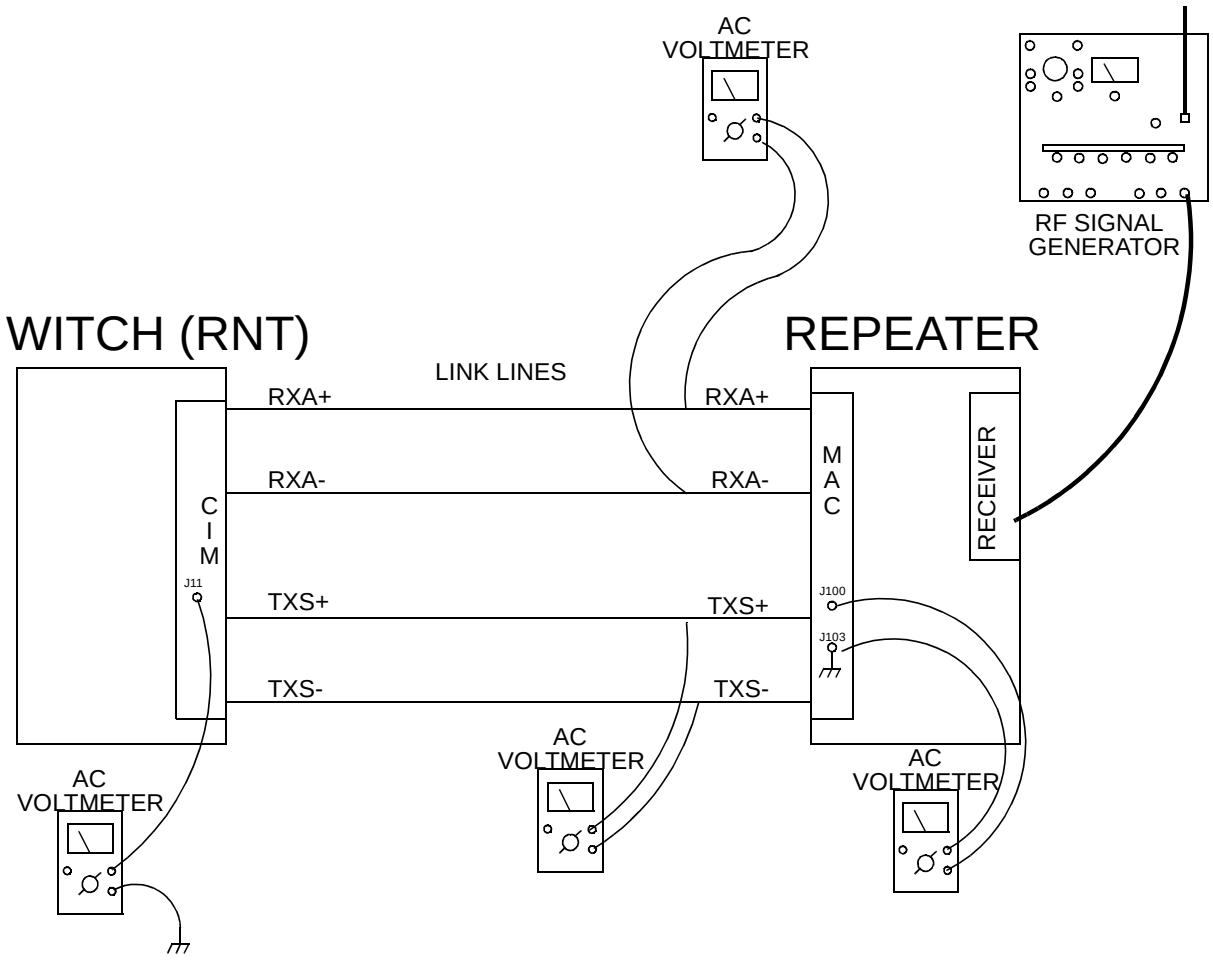


Figure 7-11 REPEATER TO CIM TEST SETUP

7.5 FULL REPEATER ALIGNMENT

7.5.1 PERFORMANCE TEST PROGRAM

1. Select the TEST - FULL REPEATER - ALL TEST and press Enter.

7.5.2 REPEATER SETUP

The Summit QX repeater has been pretested at the factory, therefore only performance tests are required to check the repeater. Refer to test setup diagrams for equipment and cabling diagram.

Turn on the repeater power supply switch (S508) in the IAC or engage the locking lever (see Figure 7-22).

The operating code has been programmed at the factory. The parameters are programmed into the MPC. If these parameters have changed or are incorrect, exit this test and reprogram the repeater.

It may be necessary to remove the RF assembly from the chassis and connect via extension cables for some of the tests or adjustments.

NOTE: All audio generators and audio voltmeters are unbalanced unless specifically stated otherwise.

7.5.3 TRANSMITTER TEST/ADJUSTMENTS

Transmit Mode

1. Press the space bar to key the repeater.

2. The Transmit LED on the IAC should turn on to indicate the repeater is transmitting (see Figure 7-22).

3. Press the space bar to unkey the repeater.

Transmit TCXO Frequency Adjustment

C R I T I C A L A D J U S T M E N T

The TCXO must be adjusted within 5 minutes of turning the AC power on to the repeater. Do not under any circumstances try to set frequency later on in any of the tests, as TCXO frequency stability cannot then be guaranteed.

4. Press the space bar to key the repeater.

5. Check the frequency of the transmitted signal. The frequency should be ±50 Hz of the channel frequency.

6. Adjust the frequency with Y401 (TCXO) on the Exciter (see Section 7.2.5).

7. Press the space bar to unkey the repeater.

Transmitter Output Power Adjustment

1. Press the space bar to key the repeater.

2. Check the transmit output power. The power can be adjusted from the computer using the cursor Up/Dn and PgUp/PgDn keys. The test equipment should be calibrated for ±2W.

3. Press the space bar to unkey the repeater.

7.5.4 RECEIVER TESTS/ADJUSTMENT

NOTE: If this is a voting repeater, it is not equipped with a receiver.

Receiver TCXO Frequency Adjustment

C R I T I C A L A D J U S T M E N T

The TCXO must be adjusted within 5 minutes of turning the AC power on to the repeater. Do not under any circumstances try to set frequency later on in any of the tests, as TCXO frequency stability cannot then be guaranteed.

1. Check the receiver injection frequency by using a "sniffer" pickup loop, or RF probe connected to a suitable frequency counter placed near L210 in the Receiver (see Section 7.1.4).

2. Adjust Y201 (TCXO) on the Receiver to within ±50 Hz of the channel frequency.

Receiver Audio Distortion Measurement

1. Adjust the RF generator for 100 µV into the receiver with a 1 kHz tone at ±3 kHz deviation.

2. Insert test cables into J100/J103 on the MAC and connect to an AC voltmeter.

3. Adjust R237 for 0 dBm (775 mV RMS).

4. Connect a 16 ohm load and distortion analyzer to J101 or J104 of the MAC.

5. Adjust R236 for 2.8V RMS and measure the distortion. Distortion should be < 3%.

Receiver Hum and Noise Measurement

1. Adjust the RF generator for 100 µV into the receiver with a 1 kHz tone at ±3 kHz.

2. Connect a 16 ohm load and distortion analyzer to J101 or J104 of the MAC.

3. Adjust R236 for 2.8V RMS.

4. Remove modulation from the RF generator. The measured level must be ≤ -45 dB.

Receiver SINAD Measurement

1. Adjust the RF generator for 100 µV into the receiver with a 1 kHz tone at ±3 kHz.

2. Connect a 16 ohm load and distortion analyzer to J101 or J104 of the MAC.

3. Adjust R236 for 2.8V RMS.

4. Re-adjust RF level for 12 dB SINAD.
12 dB SINAD reading should be ≤ 0.35 µV.

Receiver Squelch Adjustment

1. Adjust the RF generator for 100 µV into the receiver with a 1 kHz tone at ±3 kHz.

2. Connect a 16 ohm load and distortion analyzer to J101 or J104 of the MAC.

3. Adjust R236 for 2.8V RMS.

4. Set the RF generator output for 5 dB SINAD.

5. Adjust R234 on the MAC so the Receiver just squelches.

6. Increase the RF generator output until the Receiver unsquelches. Reading should be ≤ 10 dB SINAD.

Receiver Data Level Adjustment

1. Adjust the RF generator for 100 µV into the receiver with a 100 Hz tone at ±1 kHz.

2. Insert test cables into J100/J103 on the MAC and connect to an AC voltmeter.

3. Adjust R235 to achieve 340 mV RMS.

Local Speaker/Microphone Check

1. Adjust the RF generator for 100 µV into the receiver with a 1 kHz tone at ±3 kHz.

2. Plug a Speaker/Microphone into J101/J102 of the MAC.

3. Adjust R236 until the 1 kHz tone is heard.

Receiver Desense Check

1. Adjust the RF generator for 100 µV into the receiver with a 1 kHz tone at ±3 kHz.

2. Connect a 16 ohm load and distortion analyzer to J101 or J104 of the MAC.

3. Adjust R236 for 2.8V RMS.

4. Re-adjust the RF generator output for 12 dB SINAD.

5. Press the space bar to key the transmitter.

6. SINAD should not degrade more than 1 dB or to no less than 11 dB SINAD.

7. Press the space bar to unkey the transmitter.

Receiver Miscellaneous Tests (Optional)

Several additional tests may be performed on the Repeater Receiver as listed below:

- Signal Displacement Bandwidth
- Adjacent Channel Rejection
- Offset Channel Selectivity
- Intermodulation Rejection
- Spurious Rejection
- Audio Response
- Audio Sensitivity

Perform the Test desired using the appropriate RF Generators, modulation frequencies, levels, RS-232 levels and test probes following the latest TIA document measurement procedures.

7.5.5 TRANSMIT AUDIO/DATA LEVEL ADJUSTMENTS

NOTE: All audio generators and audio voltmeters are unbalanced unless specifically stated otherwise.

Audio Deviation Limit Adjustment

1. Apply a 1 kHz tone at -3 dBm (548 mV RMS) to P100, pin 32 of the MAC.
2. Insert test cables into J100/J103 and connect to an AC voltmeter.
3. Press the space bar to key the transmitter.
4. Adjust R305 for 0 dBm (775 mV RMS).
5. Press the space bar to unkey the transmitter.
6. Apply a 1 kHz tone at +7 dBm (1.73V RMS) to P100, pin 32 of the MAC. (Set modulation analyzer LPF to 3 kHz.)
7. Press the space bar to key the transmitter.
8. Adjust U149 with the PgUp/PgDn and CurUp/CurDn keys to set the maximum allowed deviation at ±3.5 kHz (±200 Hz) (±2.5 kHz for NPSPAC).
9. Press the space bar to unkey the transmitter.
10. Remove the signal from P100, pin 32.

Repeat Audio Level Adjustment

NOTE: Audio Deviation Limit Adjustment must be completed before this test.

1. Adjust the RF generator for 100 µV into the receiver with a 1 kHz tone at ±1.5 kHz dev. (±1.2 kHz for NPSPAC). Be sure the Modulation Analyzer LPF switch is set to 3 kHz.
2. Press the space bar to key the transmitter.
3. Adjust R237 on the MAC to achieve ±1.5 kHz (±100 Hz) transmit deviation (±1.2 kHz for NPSPAC). Be sure the Modulation Analyzer LPF switch is set to 3 kHz.
4. Press the space bar to unkey the transmitter.
5. Connect an AC voltmeter to J103 and P100, pin 31 (RX_VOICE).
6. Adjust R238 for -3 dBm (548 mV RMS).
7. Remove the RF generator from the Receiver.

Data Level Adjustment

1. Set modulation analyzer LPF switch to 3 kHz. Press the space bar to key the transmitter.
2. Adjust U151 with the PgUp/PgDn and CurUp/CurDn keys to achieve ±1 kHz (±100 Hz) transmit deviation.
3. Press the space bar to unkey the transmitter.

Audio/Data Deviation Check

1. Apply a 1 kHz tone at +7 dBm (1.73V RMS) to P100, pin 32 of the MAC. Set modulation analyzer LPF to 3 kHz.
2. Press the space bar to key the transmitter.
3. Measured deviation should be ±4.5 kHz (±200 Hz) (±3.5 kHz NPSPAC).
4. Press the space bar to unkey the transmitter.
5. Disconnect all cables.

CWID Level Check

1. Set modulation analyzer LPF switch to 3 kHz. Press the space bar to key the transmitter.

2. Deviation should be 1.5 kHz to 2.5 kHz.

3. Press the space bar to unkey the transmitter.

Local Speaker/Microphone Check

1. Plug a Speaker/Microphone into J101/J102 of the MAC. Set modulation analyzer LPF switch to 3 kHz.

2. Press the microphone PTT and say "four" loudly into the microphone.

3. Deviation should be ±3 to ±3.5 kHz (±2 to ±2.5 kHz for NPSPAC).

4. Release the microphone PTT.

5. Press the space bar to unkey the transmitter.

Transmitter Hum and Noise Ratio (Optional)

NOTE: An HP8901A modulation analyzer is required for this test.

1. On the modulation analyzer press:
   300 Hz HPF
   3000 Hz LPF
   FM
   Pre-Display
   750 µS
   Avg RMS Cal
   .44
   dB

2. Press the space bar to key the transmitter and measure the Hum and Noise Ratio. The reading should be < -45 dB.

3. Press the space bar to unkey the transmitter.

Transmit Audio Distortion

1. On the modulation analyzer select:
   FM
   50 Hz
   15 kHz

2. Apply -11.7 dBm at 1 kHz to P100, pin 32 of the MAC.

3. Press the space bar to key the transmitter.

4. Adjust audio level to produce ±1 kHz dev.

5. On the modulation analyzer select:

   300 Hz
   3 kHz
   750 µs de-emphasis

6. Distortion should be < 2 kHz.

7.5.6 VOTER AUDIO LEVEL ADJUSTMENT

NOTE: Use an unbalanced audio voltmeter.

1. Inject a 1 kHz tone at -12 dBm (194 mV RMS) into J2, pin 17. This tone represents ±1.5 kHz deviation in the Voter Receiver.

2. Adjust R233 for a level of -6 dBm (387 mV RMS) at J100/J103 on the MAC.

7.5.7 AUDIO/DATA LEVEL ADJUSTMENTS

NOTE: Section 7.5.5 must be completed before any of the following adjustments can be made.

NOTE: All audio generators and audio voltmeters are unbalanced unless specifically stated otherwise.

Voice Audio From Repeater

1. Set MAC S100 and S101 to all Sections OFF.

2. Adjust the RF generator for 100 µV into the receiver with a 1 kHz tone at ±1.5 kHz dev.

3. Connect a **balanced** AC voltmeter with a 600 ohm input impedance between balanced lines RXA+ and RXA- on J2, located on the back of the Repeater.

4. Adjust R239 on the MAC for the type of line.

   Leased Line/Direct Connect (default)
   -12 dBm (194 mV RMS)

   Microwave/T1 (optional)
   -28 dBm (31 mV RMS)

Voice Audio To Repeater

1. Set MAC S100 and S101 to all Sections OFF (see Figure 7-12).

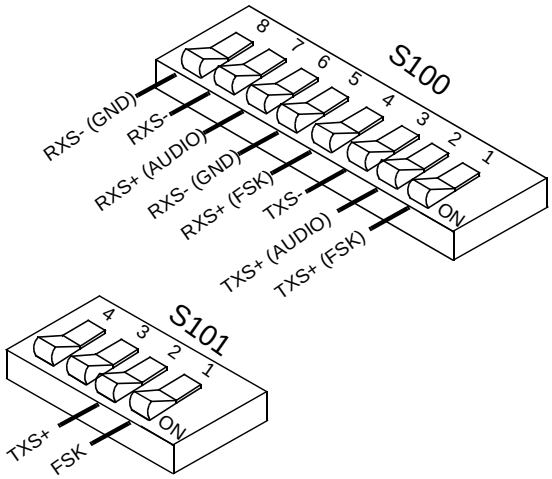


Figure 7-12 S100 SETTING

2. Inject a 1 kHz tone from a **balanced** 600 ohm source, at the level determined by the type of line used, into TXA+ and TXA- of J2 located on the back of the Repeater (see Figure 7-16).

   Leased Line/Direct Connect (default)
   -12 dBm (194 mV RMS)

   Microwave/T1 (optional)
   -28 dBm (31 mV RMS)

3. Adjust R243 on the MAC to obtain -6 dBm (387 mV RMS) measured at J100/J103.

FSK Data Level Adjustment To Repeater
Separate Data Path (4-Wire) Optional Setting.

1. Set MAC S100 Sections 1, 4, 5, 8 OFF; 2, 3, 6, 7 ON; S101 Sections 2, 3, 4 OFF; 1 ON (see Figure 7-13).

2. Inject a 1.2 kHz tone from a **balanced** 600 ohm source, at the level determined by the type of line used, into TXS+ and TXS- of J2 located on the back of the Repeater (see Figure 7-14).

   Leased Line/Direct Connect (default)
   -12 dBm (194 mV RMS)

   Microwave/T1 (optional)
   -28 dBm (31 mV RMS)

3. Adjust R242 on the MAC to obtain -10 dBm (245 mV RMS) measured at J100/J103.

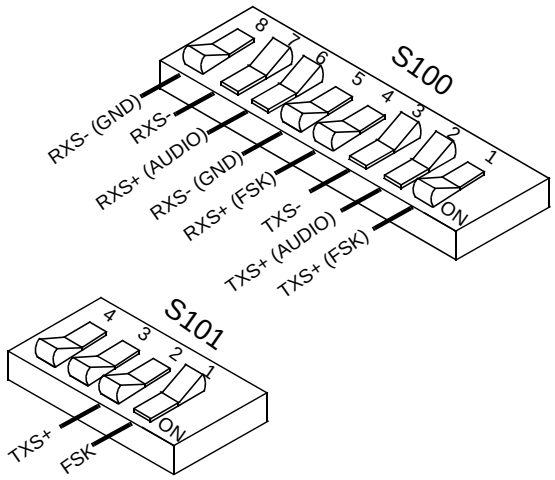


Figure 7-13 S100/S101 SWITCH SETTINGS

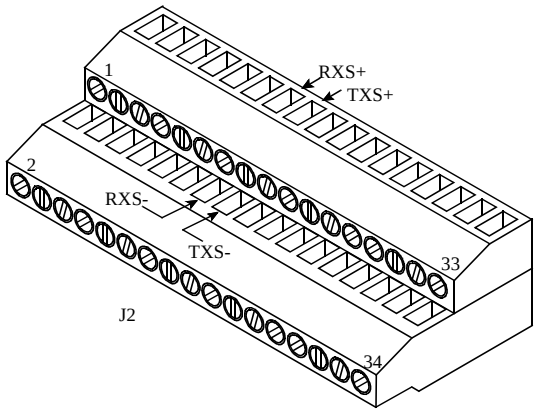


Figure 7-14 J2 TERMINAL BLOCK (SECONDARY)

FSK Data Level Adjustment To Repeater
Data over Voice (2-Wire) Default Setting.

1. Set MAC S100, all Sections OFF; S101 Sections 2, 3, 4 OFF; 1 ON (see Figure 7-15).

2. Inject a 1.2 kHz tone from a **balanced** 600 ohm source, at the level determined by the type of line used, into TXA+ and TXA- of J2 located on the back of the Repeater (see Figure 7-16).

   Leased Line/Direct Connect (default)
   -22 dBm (62 mV RMS)

   Microwave/T1 (optional)
   -38 dBm (10 mV RMS)

3. Adjust R242 on the MAC to obtain -10 dBm (245 mV RMS) measured at J100/J103.

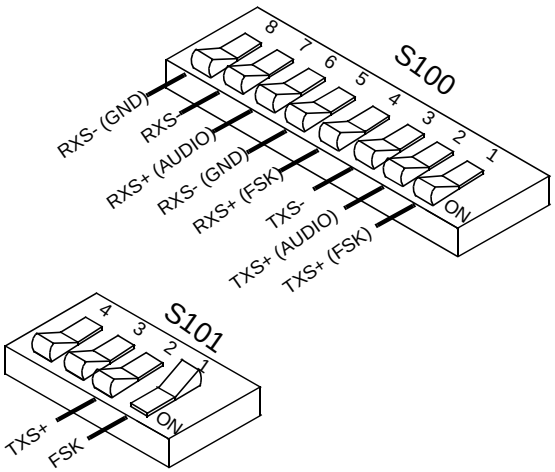


Figure 7-15 SWITCH SETTINGS

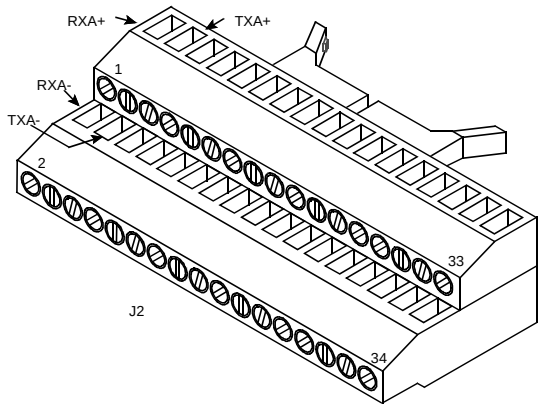


Figure 7-16 J2 TERMINAL BLOCK

FSK Data Level Adjustment From Repeater
Separate Data Path (4-Wire) Optional Setting.

1. Set MAC S100 Sections 1, 4, 5, 8 OFF; 2, 3, 6, 7 ON; S101 Sections 2, 3, 4 OFF; 1 ON (see Figure 7-15).

2. Adjust R240 on the MAC to obtain -16 dBm (123 mV RMS) measured at J100/J103.

3. Press F2 to advance to the next screen.

4. Connect a **balanced** AC Voltmeter with a 600 ohm input impedance between balanced lines RXS+ and RXS- of J2 located on the back of the Repeater (see Figure 7-14).

5. Adjust R241 on the MAC for the type of line used.

   Leased Line/Direct Connect (default)
   -12 dBm (194 mV RMS)

   Microwave/T1 (optional)
   -28 dBm (31 mV RMS)

FSK Data Level Adjustment From Repeater
Data over Voice (2-Wire) Default Setting.

NOTE: This adjustment can only be done after Voice Audio To Switch is completed.

1. Set MAC S100, all Sections OFF; S101 Sections 2, 3, 4 OFF; 1 ON (see Figure 7-15).

2. Connect a **balanced** AC Voltmeter with a 600 ohm input impedance between balanced lines RXA+ and RXA- of J2 located on the back of the Repeater (see Figure 7-16).

3. Adjust R240 on the MAC for the type of line used.

   Leased Line/Direct Connect (default)
   -22 dBm (62 mV RMS)

   Microwave/T1 (optional)
   -38 dBm (10 mV RMS)

RS-232 Data To And From Switch (RNT) (Optional)

These are the switch settings only.

1. Set MAC S100, Sections 2, 3, 6, 7 OFF; 1, 4, 5, 8 ON (see Figure 7-17).

2. Set MAC S101, Sections 1, 3, 4 OFF; 2 ON (see Figure 7-17).

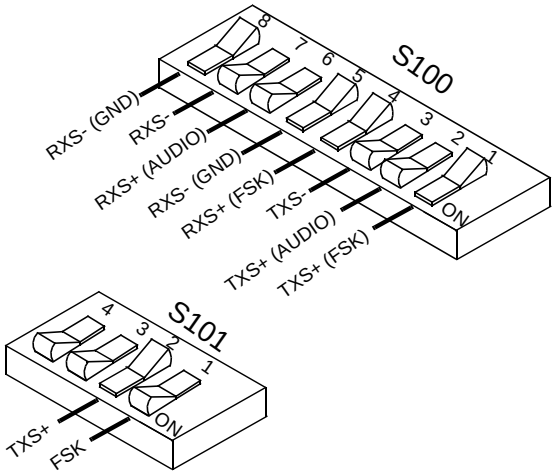


Figure 7-17 S100/S101 RS-232

7.5.8 REPEATER OPERATION

New HSDB Test

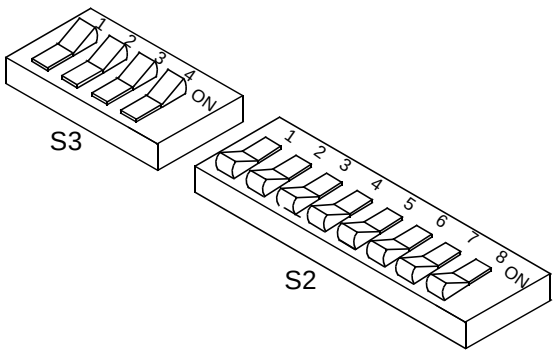


Figure 7-18 NEW HSDB SWITCH SETTINGS

3. Switch settings on the MPC for RS-485 (new style) operation are shown in Figure 7-18. S002 all Section On. S003 all Section Off.

4. Verify that the repeater is programmed for "Stand Alone" mode in Setup Parameters-F4 (see Section 4.3.1).

5. The repeater is now in Normal Operation mode. Verify by the MPC front panel indicators that no HSDB alarms have occurred (Alarm Number 10) see Table 1-2.

Old HSDB Test

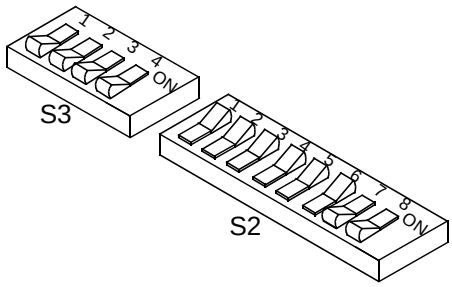


Figure 7-19 OLD HSDB SWITCH SETTINGS

1. Switch settings on the MPC for single-ended 5V (old style) operation are shown in Figure 7-19. S002 Sections 1-6 Off; 7, 8 On. S003 all sections On.

2. Verify that the repeater is programmed for "Stand Alone" mode in Setup Parameters-F4 (see Section 4.3.1).

3. The repeater is now in Normal Operation mode. Verify by the MPC front panel indicators that no HSDB alarms have occurred (Alarm Number 10) see Table 1-2.

Handshake Test

1. Program a Multi-Net, portable or mobile for the following parameters.

Multi-Net
Home Repeater - Same as repeater number.
System Key - Same as repeater.
Status Channel - Same as repeater channel.
Home Channel - Same as repeater channel.
Encode ID - 1
Decode ID - 1
UID - 1
Site - 1

2. The repeater is in Normal Operation mode.

3. Key the radio several times on the programmed System/Group. Access should occur every time. (Proper Tx/Rx antenna connections are assumed.)

Alarm Test

1. The repeater is now in Normal Operation mode.

2. Verify by the MPC front panel indicators that no alarms have occurred (see Table 1-2).

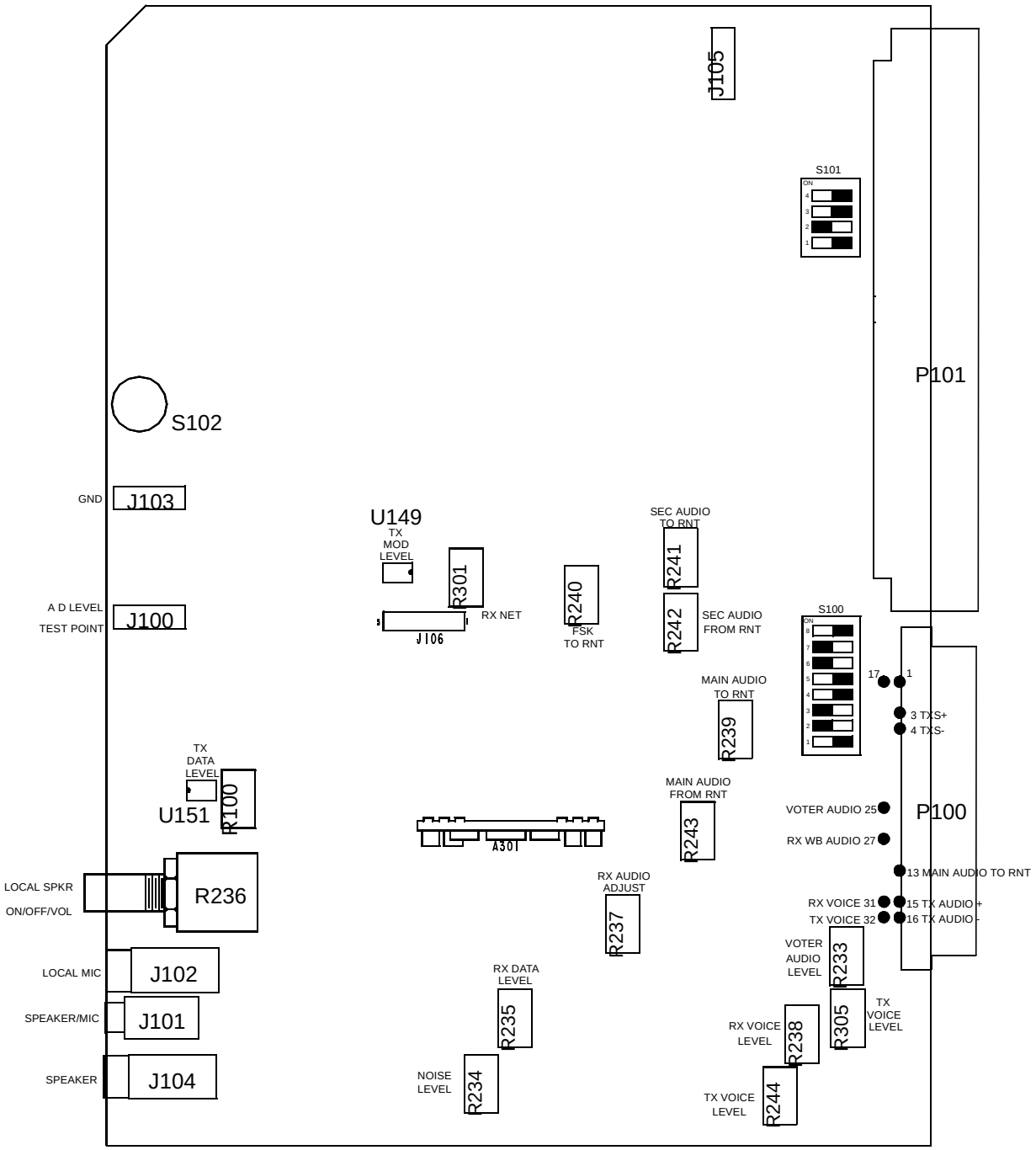


Figure 7-20 MAC ALIGNMENT POINTS

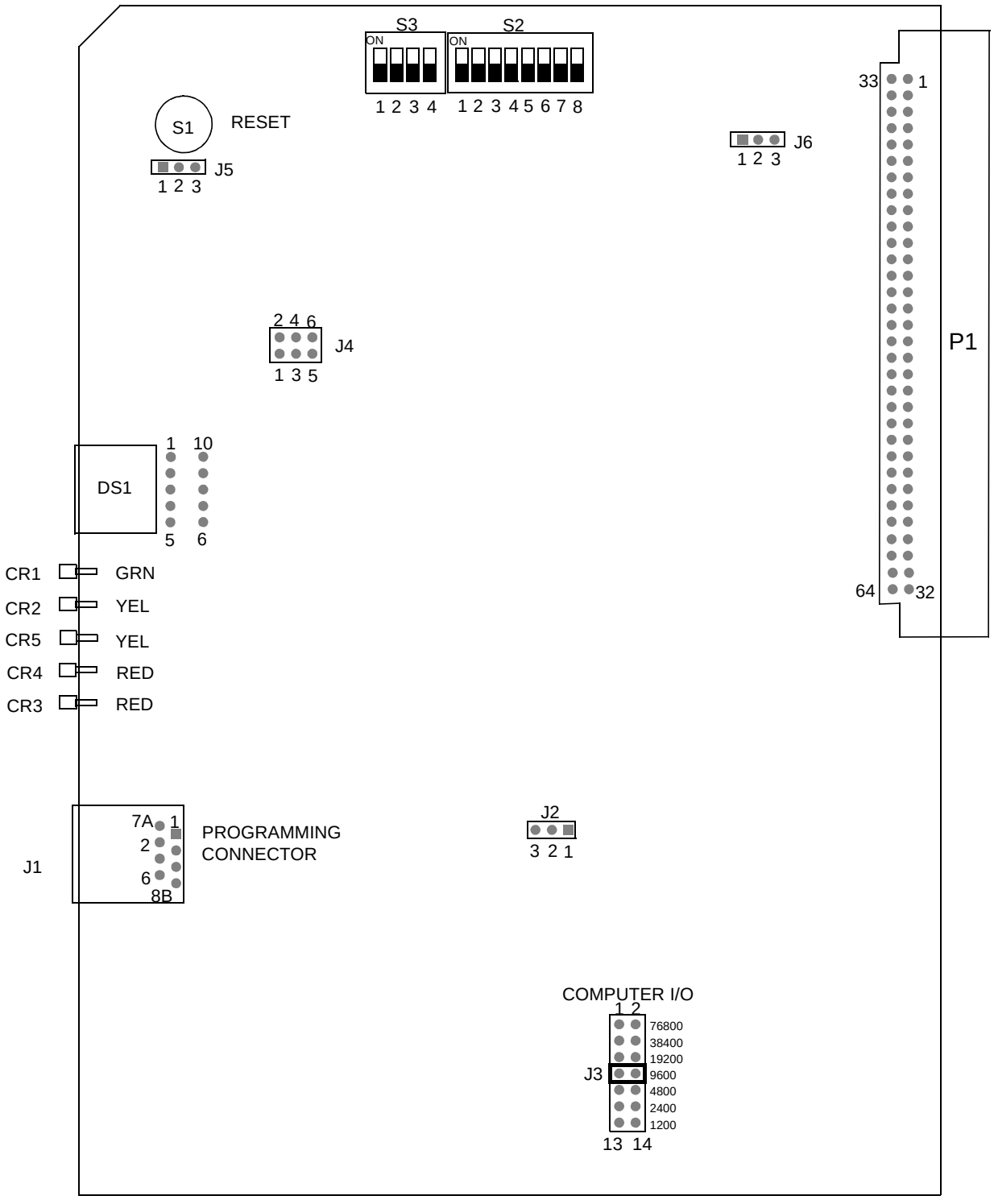


Figure 7-21 MAIN PROCESSOR CARD ALIGNMENT POINTS

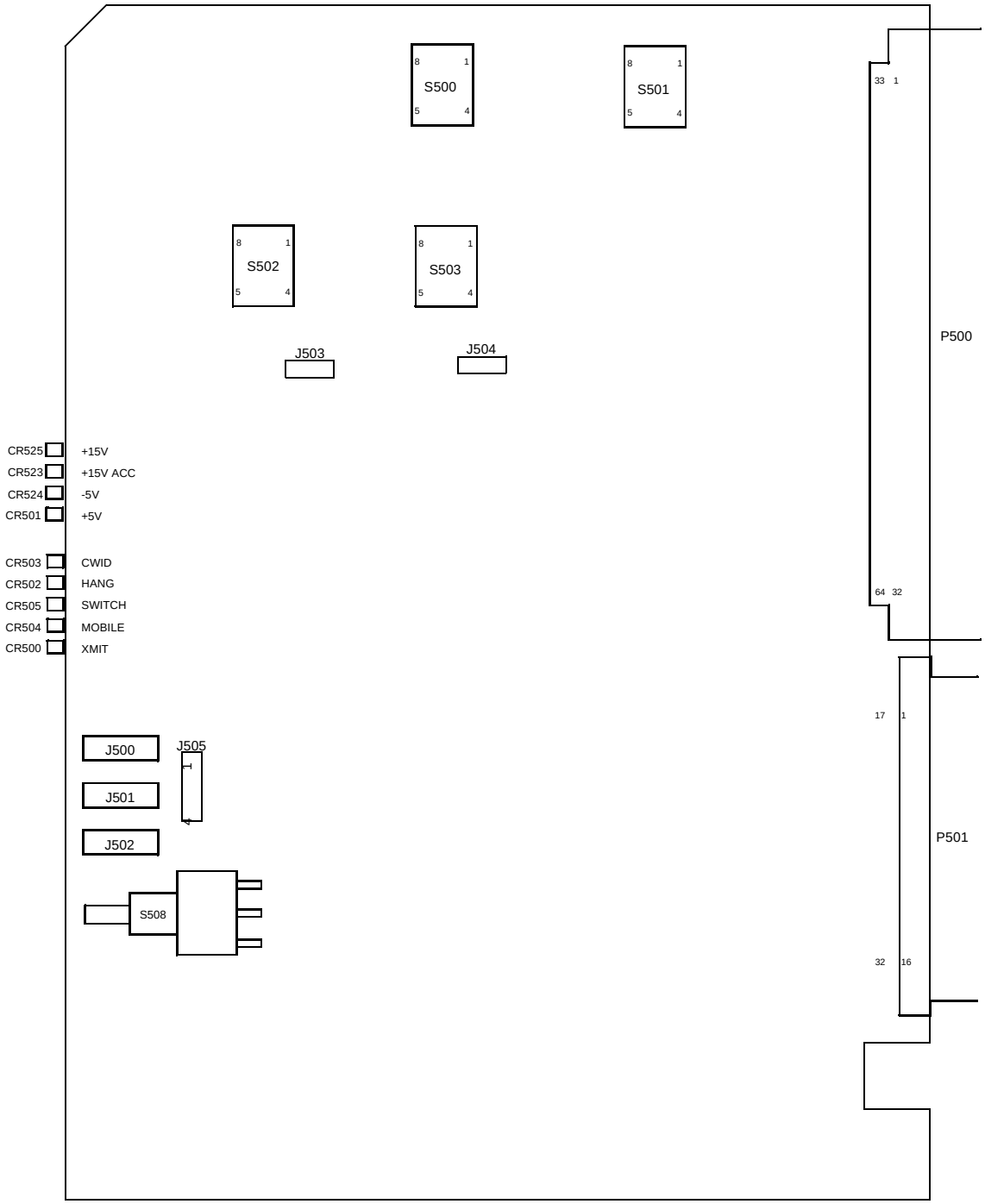


Figure 7-22 INTERFACE ALARM CARD ALIGNMENT POINTS

7.6 SWITCH (RNT) INTERFACE

7.6.1 REPEATER SETUP

1. Connect the repeater as shown in Figures 7-11, 7-24 and 7-25.

2. Adjust the repeater for the type of link used for communication back to the CIM in the Switch. The types of links used are: Leased Lines (LL), Direct Connection (DC), Microwave (MW), and T1 Interfaces (T1).

3. Program the repeater for the specified parameters using the PC Programmer.

NOTE: Assume all audio generators and voltmeters to be unbalanced unless stated otherwise.

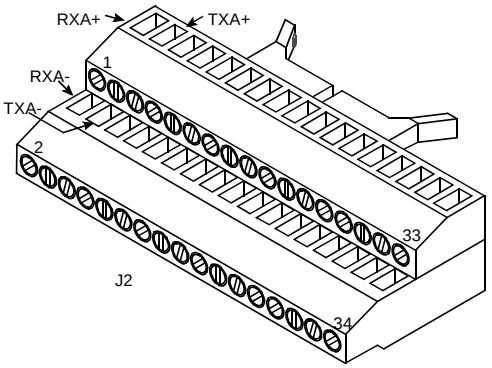


Figure 7-24 J2 CONNECTOR

7.6.2 CIM SETUP

1. Adjust the CIM for the type of link used for communication back to the repeater. The types of links used are: Leased Lines (LL), Direct Connection (DC), Microwave (MW), and T1 Interfaces (T1). Refer to the latest Multi-Net Radio Network Terminal Setup and Alignment manual, Part No. 001-3039-00*x*, for more information on the CIM alignment (see Figure 7-34).

2. Connect the link lines to the Switch and its associated CIM (see Figures 7-25).

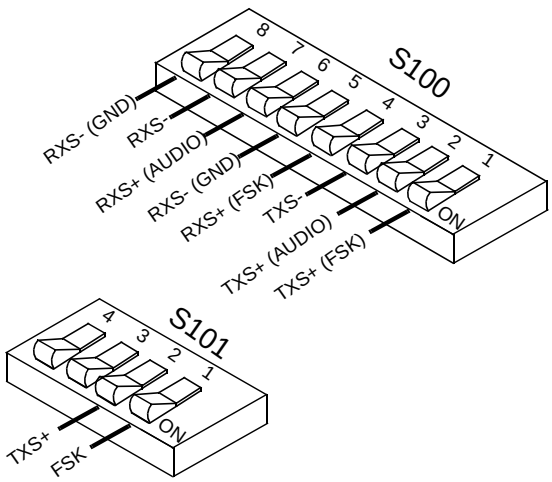


Figure 7-23 S100/S101 SWITCH SETTING

7.6.3 DATA OVER VOICE

1. Voice Audio To Switch (RNT)

   a. Set MAC S100, all Sections OFF, S101 all Sections OFF (see Figure 7-23).

   b. Connect an RF generator to the receiver.

   c. Adjust the RF generator for 100 µV modulated with a 1 kHz tone at ±1.5 kHz deviation.

<u>Repeater Adjustment With LL/DC Lines (Default)</u>

   a. Connect a **balanced** AC voltmeter with 600 ohm input impedance between balanced lines RXA+ and RXA- of J2 located on the back of the repeater (see Figure 7-24 and 7-25).

   b. Adjust R239 on the MAC for -12 dBm (194 mV RMS) (see Figure 7-20).

<u>CIM Adjustment With LL/DC Lines (Default)</u>

   a. Connect an AC voltmeter between J11 and J13 (ground) on the CIM board (see Figure 7-34).

   b. Adjust R41 on the CIM for -6 dBm (387 mV RMS).

Repeater Adjustment With MW/T1 Lines (Optional)

a. Connect a **balanced** AC voltmeter with 600 ohm input impedance between balanced lines RXA+ and RXA- of J2 on the back of the repeater (see Figure 7-24).

b. Adjust R239 on the MAC for -28 dBm (31 mV RMS) (see Figure 7-20).

CIM Adjustment With MW/T1 Lines (Optional)

a. Connect an AC voltmeter between J11 and ground on the CIM board.

b. Adjust R41 on the CIM for -6 dBm (387 mV RMS) (see Figure 7-34).

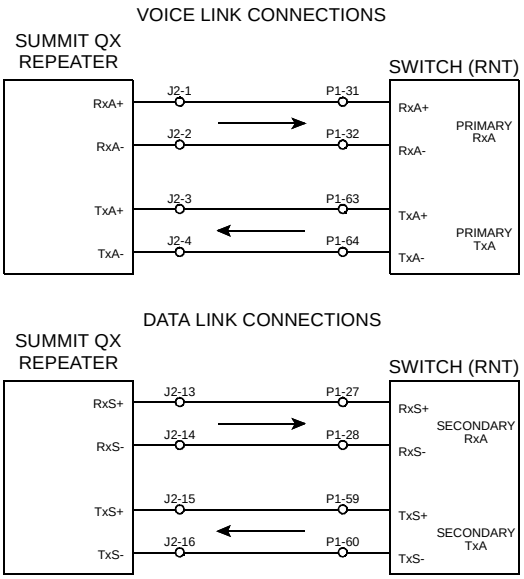


Figure 7-25 SUMMIT QX VOICE/DATA LINK

2. Voice Audio From Switch (RNT)

a. Set MAC S100 all Sections OFF, S101 all Sections OFF (see Figure 7-23).

CIM Adjustment With LL/DC Lines (Default)

a. Set the CIM in the Switch to generate an alignment tone (set S5 to "1") (see Figure 7-34).

b. Adjust R44 for -12 dBm (192 mV RMS) at J12.

Repeater Adjustment With LL/DC Lines (Default)

a. Connect a **balanced** AC voltmeter between J100 and J103 on the MAC.

b. Adjust R243 on the MAC for -6 dBm (387 mV RMS).

CIM Adjustment With MW/T1 Lines (Optional)

a. Set the CIM in the Switch to generate an alignment tone (set S5 to a value of "1").

b. Adjust R44 for -28 dBm (31 mV RMS) at J12.

Repeater Adjustment With MW/T1 Lines (Default)

a. Connect a **balanced** AC voltmeter between J100 and J103 on the MAC.

b. Adjust R243 on the MAC for -6 dBm (387 mV RMS).

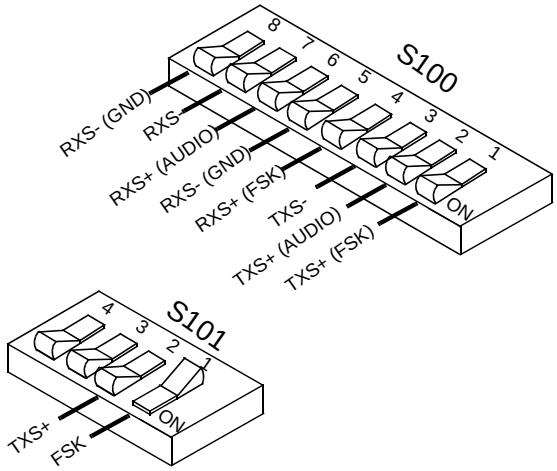


Figure 7-26 MAC SWITCH SETTINGS

3. FSK Data Level Adjustment From Switch (RNT)

NOTE: This adjustment can only be done after 2. Voice Audio From Switch is completed.

a. Set MAC S100 all Sections OFF; S101 Sections 2, 3, 4 OFF; 1 ON (see Figure 7-26).

CIM Adjustment With LL/DC Lines (Default)

a. Set the CIM in the Switch to generate an alignment tone (set S5 to a value of "8").

b. Adjust R86 for -12 dBm (194 mV RMS) at TP4.

c. Verify -21 dBm (69 mV RMS) at J12 (see Figure 7-34).

Repeater Adjustment With LL/DC Lines (Default)

a. Connect a **balanced** AC voltmeter between J100 and J103 on the MAC.

b. Adjust R242 on the MAC for -10 dBm (245 mV RMS).

CIM Adjustment With MW/T1 Lines (Optional)

a. Set the CIM in the Switch to generate an alignment tone (set S5 to a value of "8").

b. Adjust R86 for -28 dBm (31 mV RMS) at TP4.

c. Verify -37 dBm (11 mV RMS) at J12 (see Figure 7-34).

Repeater Adjustment With MW/T1 Lines (Default)

a. Connect a **balanced** AC voltmeter between J100 and J103 on the MAC.

b. Adjust R242 on the MAC for -10 dBm (245 mV RMS).

4. FSK Data Level Adjustment To Switch (RNT)

NOTE: This adjustment can only be done after 1. Voice Audio To Switch is completed.

a. Set MAC S100 all Sections OFF; S101 Sections 2, 3, 4 OFF; 1 ON (see Figure 7-26).

Repeater Adjustment With LL/DC Lines (Default)

a. Connect a **balanced** AC voltmeter with 600 ohm input impedance between balanced lines RXA+ and RXA- of J2 located on the back of the Repeater (see Figure 7-24).

b. Adjust R240 on the MAC for -22 dBm (62 mV RMS) (see Figure 7-20).

CIM Adjustment With LL/DC Lines (Default)

a. Connect an AC voltmeter between TP8 and ground on the associated CIM board.

b. Adjust R102 on the CIM for -12 dBm (194 mV RMS) (see Figure 7-34).

Repeater Adjustment With MW/T1 Lines (Optional)

a. Connect a **balanced** AC voltmeter with 600 ohm input impedance between balanced lines RXA+ and RXA- of J2 located on the back of the Repeater (see Figure 7-24).

b. Adjust R240 on the MAC for -38 dBm (10 mV RMS) (see Figure 7-20).

CIM Adjustment With MW/T1 Lines (Optional)

a. Connect an AC voltmeter between TP8 and ground on the associated CIM board.

b. Adjust R102 on the CIM for -12 dBm (194 mV RMS) (see Figure 7-34).

7.6.4 SEPARATE DATA

1. Voice Audio To Switch (RNT)

a. Set MAC S100, all Sections OFF, S101 all Sections OFF (see Figure 7-23).

b. Connect an RF generator to the receiver.

c. Adjust the RF generator for 100 µV modulated with a 1 kHz tone at ±1.5 kHz deviation.

Repeater Adjustment With LL/DC Lines (Default)

a. Connect a **balanced** AC voltmeter with 600 ohm input impedance between balanced lines RXA+ and RXA- of J2 located on the back of the Repeater (see Figure 7-24 and 7-25).

b. Adjust R239 on the MAC for -12 dBm (194 mV RMS) (see Figure 7-20).

CIM Adjustment With LL/DC Lines (Default)

a. Connect an AC voltmeter between J11 and ground on the CIM (see Figure 7-34).

b. Adjust R41 on the CIM for -6 dBm (387 mV RMS).

Repeater Adjustment With MW/T1 Lines (Optional)

a. Connect a **balanced** AC voltmeter with 600 ohm input impedance between balanced lines RXA+ and RXA- of J2 on the back of the Repeater (see Figure 7-24).

b. Adjust R239 on the MAC for -28 dBm (31 mV RMS) (see Figure 7-20).

CIM Adjustment With MW/T1 Lines (Optional)

a. Connect an AC voltmeter between J11 and ground on the CIM board.

b. Adjust R41 on the CIM for -6 dBm (387 mV RMS) (see Figure 7-34).

Voice Audio From Switch (RNT)

a. Set MAC S100 all Sections OFF, S101 all Sections OFF (see Figure 7-23).

CIM Adjustment With LL/DC Lines (Default)

a. Set the CIM in the Switch to generate an alignment tone (set S5 to "1") (see Figure 7-34).

b. Adjust R44 for -12 dBm (192 mV RMS) at J12.

Repeater Adjustment With LL/DC Lines (Default)

a. Connect a **balanced** AC voltmeter between J100 and J103 on the MAC.

b. Adjust R243 on the MAC for -6 dBm (387 mV RMS).

CIM Adjustment With MW/T1 Lines (Optional)

a. Set the CIM in the Switch to generate an alignment tone (set S5 to a value of "1").

b. Adjust R44 for -28 dBm (31 mV RMS) at J12.

Repeater Adjustment With MW/T1 Lines (Default)

a. Connect a **balanced** AC voltmeter between J100 and J103 on the MAC.

b. Adjust R243 on the MAC for -6 dBm (387 mV RMS).

2. FSK Data Level Adjustment From Switch (RNT)

a. Set MAC S100, Sections 1, 4, 5, 8, OFF, 2, 3, 6, 7 ON; S101 Sections 2, 3, 4 OFF, 1 ON (see Figure 7-27).

CIM Adjustment With LL/DC Lines (Default)

a. Set the CIM in the Switch to generate an alignment tone (set S5 to a value of "8").

b. Adjust R90 for -12 dBm (192 mV RMS) at TP9 (see Figure 7-34).

Repeater Adjustment With LL/DC Lines (Default)

a. Connect a **balanced** AC voltmeter between J100 and J103 on the MAC.

b. Adjust R242 on the MAC for -10 dBm (245 mV RMS).

CIM Adjustment With MW/T1 Lines (Optional)

a. Set the CIM in the Switch to generate an alignment tone (set S5 to a value of "8").

b. Adjust R90 for -28 dBm (31 mV RMS) at TP9.

Repeater Adjustment With MW/T1 Lines (Default)

a. Connect a **balanced** AC voltmeter between J100 and J103 on the MAC.

b. Adjust R242 on the MAC for -10 dBm (245 mV RMS).

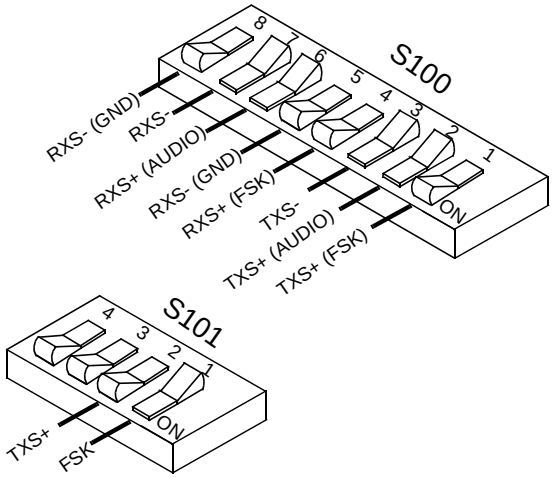


Figure 7-27 S100/S101 FSK DATA

3. FSK Data Level Adjustment To Switch (RNT)

a. Set MAC S100, Sections 1, 4, 5, 8, OFF, 2, 3, 6, 7 ON; S101 Sections 2, 3, 4 OFF, 1 ON (see Figure 7-27).

b. Connect a balanced AC voltmeter between J100 and J103 on the MAC.

c. Adjust R240 on the MAC for -16 dBm (123 mV RMS).

Repeater Adjustment With LL/DC Lines (Default)

a. Connect a **balanced** AC voltmeter with 600 ohm input impedance between balanced lines RXS+ and RXS- of J2 located on the back of the Repeater (see Figure 7-28).

b. Adjust R241 on the MAC for -12 dBm (194 mV RMS) (see Figure 7-20).

CIM Adjustment With LL/DC Lines (Default)

a. Connect an AC voltmeter between TP8 and ground on the associated CIM board.

b. Adjust R102 on the CIM for -12 dBm (194 mV RMS) (see Figure 7-34).

Repeater Adjustment With MW/T1 Lines (Optional)

a. Connect a **balanced** AC voltmeter with 600 ohm input impedance between balanced lines RXS+ and RXS- of J2 located on the back of the Repeater (see Figure 7-28).

b. Adjust R241 on the MAC for -28 dBm (31 mV RMS) (see Figure 7-20).

CIM Adjustment With MW/T1 Lines (Optional)

a. Connect an AC voltmeter between TP8 and ground on the associated CIM board.

b. Adjust R102 on the CIM for -12 dBm (194 mV RMS) (see Figure 7-34).

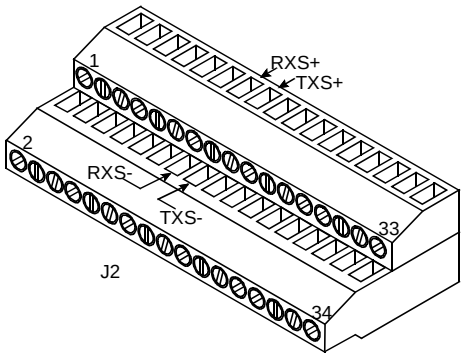


Figure 7-28 J2 CONNECTOR

7.6.5 RS-232

1. Voice Audio To Switch (RNT)

a. Set MAC S100, all Sections OFF, S101 all Sections OFF (see Figure 7-23).

b. Connect an RF generator to the Receiver.

c. Adjust the RF generator for 100 µV modulated with a 1 kHz tone at ±1.5 kHz deviation.

Repeater Adjustment With LL/DC Lines (Default)

a. Connect a **balanced** AC voltmeter with 600 ohm input impedance between balanced lines RXA+ and RXA- of J2 located on the back of the Repeater (see Figure 7-24 and 7-25).

b. Adjust R239 on the MAC for -12 dBm (194 mV RMS) (see Figure 7-20).

CIM Adjustment With LL/DC Lines (Default)

a. Connect an AC voltmeter between J11 and ground on the CIM (see Figure 7-34).

b. Adjust R41 on the CIM for -6 dBm (387 mV RMS).

Repeater Adjustment With MW/T1 Lines (Optional)

a. Connect a **balanced** AC voltmeter with 600 ohm input impedance between balanced lines RXA+ and RXA- of J2 on the back of the Repeater (see Figure 7-24).

b. Adjust R239 on the MAC for -28 dBm (31 mV RMS) (see Figure 7-20).

CIM Adjustment With MW/T1 Lines (Optional)

a. Connect an AC voltmeter between J11 and ground on the CIM board.

b. Adjust R41 on the CIM for -6 dBm (387 mV RMS) (see Figure 7-34).

2. Voice Audio From Switch (RNT)

a. Set MAC S100 all Sections OFF, S101 all Sections OFF (see Figure 7-23).

CIM Adjustment With LL/DC Lines (Default)

a. Set the CIM in the Switch to generate an alignment tone (set S5 to "1") (see Figure 7-34).

b. Adjust R44 for -12 dBm (192 mV RMS) at J12.

Repeater Adjustment With LL/DC Lines (Default)

a. Connect a **balanced** AC voltmeter between J100 and J103 on the MAC.

b. Adjust R243 on the MAC for -6 dBm (387 mV RMS).

CIM Adjustment With MW/T1 Lines (Optional)

a. Set the CIM in the Switch to generate an alignment tone (set S5 to a value of "1").

b. Adjust R44 for -28 dBm (31 mV RMS) at J12.

Repeater Adjustment With MW/T1 Lines (Default)

a. Connect a **balanced** AC voltmeter between J100 and J103 on the MAC.

b. Adjust R243 on the MAC for -6 dBm (387 mV RMS).

1. RS-232 Data To and From Switch (RNT)

These are the switch settings only.

a. Set MAC S100, Sections 2, 3, 6, 7 OFF; Sections 1, 4, 5, 8 ON (see Figure 7-29).

b. Set MAC S101, Sections 1, 3, 4 OFF; Section 2 ON (see Figure 7-29).

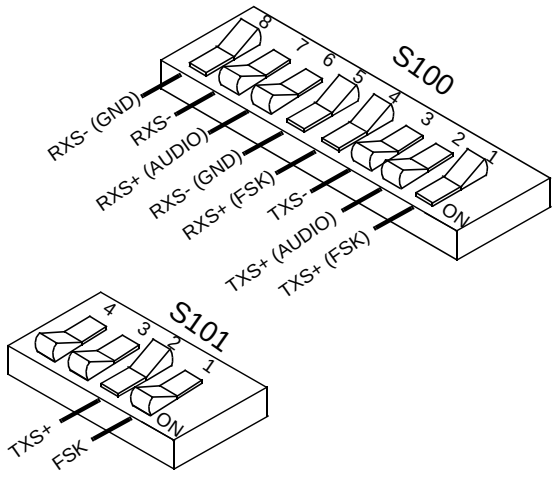


Figure 7-29 S100/S101 RS-232

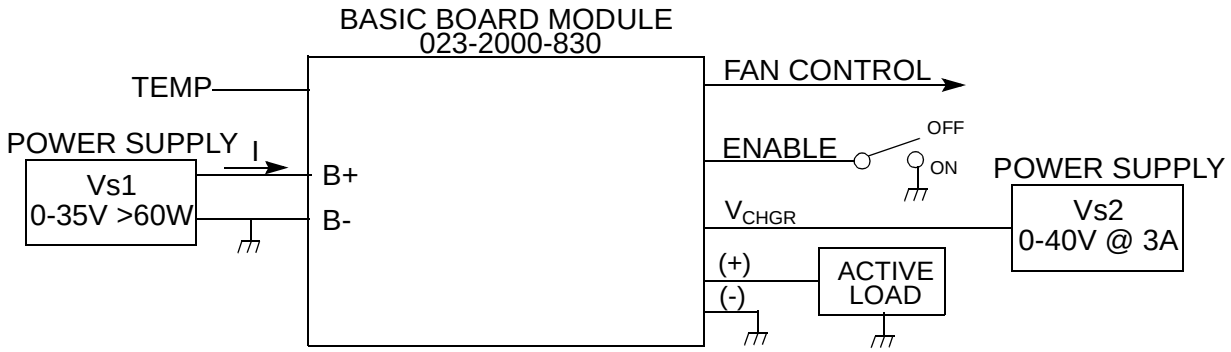


Figure 7-30 BATTERY REVERT TEST SETUP

7.7 VISUAL CHECK

1. Make sure the heat sunk parts are not shorted to the heat-sink.

2. Verify all electrolytic capacitors are installed correctly.

3. Connect 023-2000-830 Battery Back-Up as shown in Figure 7-30.

7.8 BATTERY REVERT TEST

1. Connect the circuit as shown in Figure 7-30.

2. Turn the active load to current mode at 1A.

3. Turn enable to On, battery fault LED should be on.

4. Increase Vs1 until:
   the relay engages
   the voltage is present on the active load
   the battery fault LED is off.

   This voltage will be 22V DC ±0.5V.

5. Increase Vs1 until:
   the relay disengages
   the LED lights
   no voltage is present at the active load.

   This voltage will be 31V DC ±0.5V.

6. Decrease VS1 until:
   the relay engages
   the LED goes out
   voltage is present at the active load.

   This voltage will be 28V DC ±0.5V.

7. Set Vs1 to 26.5V DC and turn the enable line to OFF. No voltage will be present at the active load.

8. Decrease Vs1 until:
   the relay disengages
   the LED lights
   no voltage is present at the active load.

   This voltage will be 19V DC ±0.5V.

9. With the enable line OFF measure current Is, it should be less than 20 mA.

10. Reverse the polarity of Vs1
    Set to 26.5V DC
    BBM Enable ON

    Reverse Battery LED will light and Is should be less than 50 mA.

11. Disconnect the test setup.

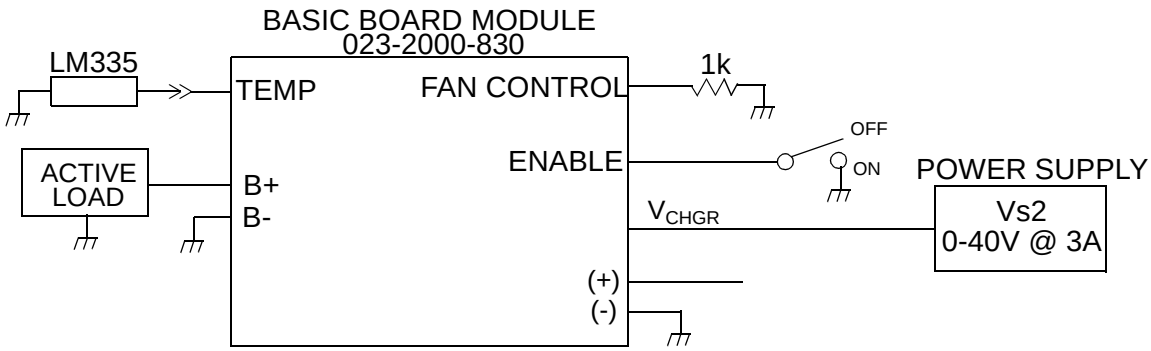


Figure 7-31 BATTERY CHARGER TEST SETUP

7.9 BATTERY CHARGER SECTION

1. Connect Battery Backup Module as shown in Figure 7-31.

2. Set the active load to 0A and set Vs2 to 40V at 3A.

3. Adjust R140 so the voltage at the active load reads 27.55V DC ±0.1V.

NOTE: The temperature sensor LM335 has to be at 22°C (room temperature).

4. Increase the active load current to 1.8A and verify voltage at the load is greater than 26V.

NOTE: The fan control line will stay at 0V until the heat sink is above 50°C.

5. Set the active load current to zero, shut off Vs2 and disconnect the BBM. Glyptol R140.

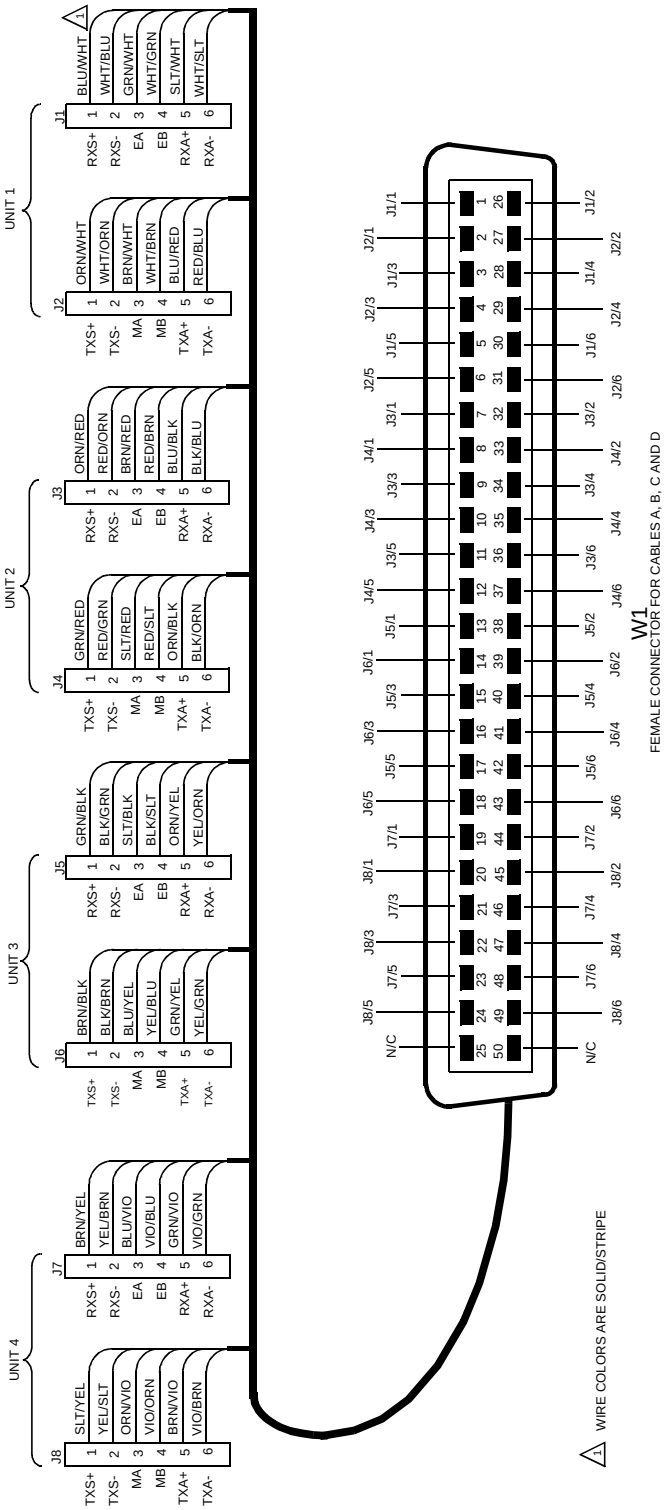


Figure 7-32 SWITCH (RNT) BACKPLANE WIREHARNESS

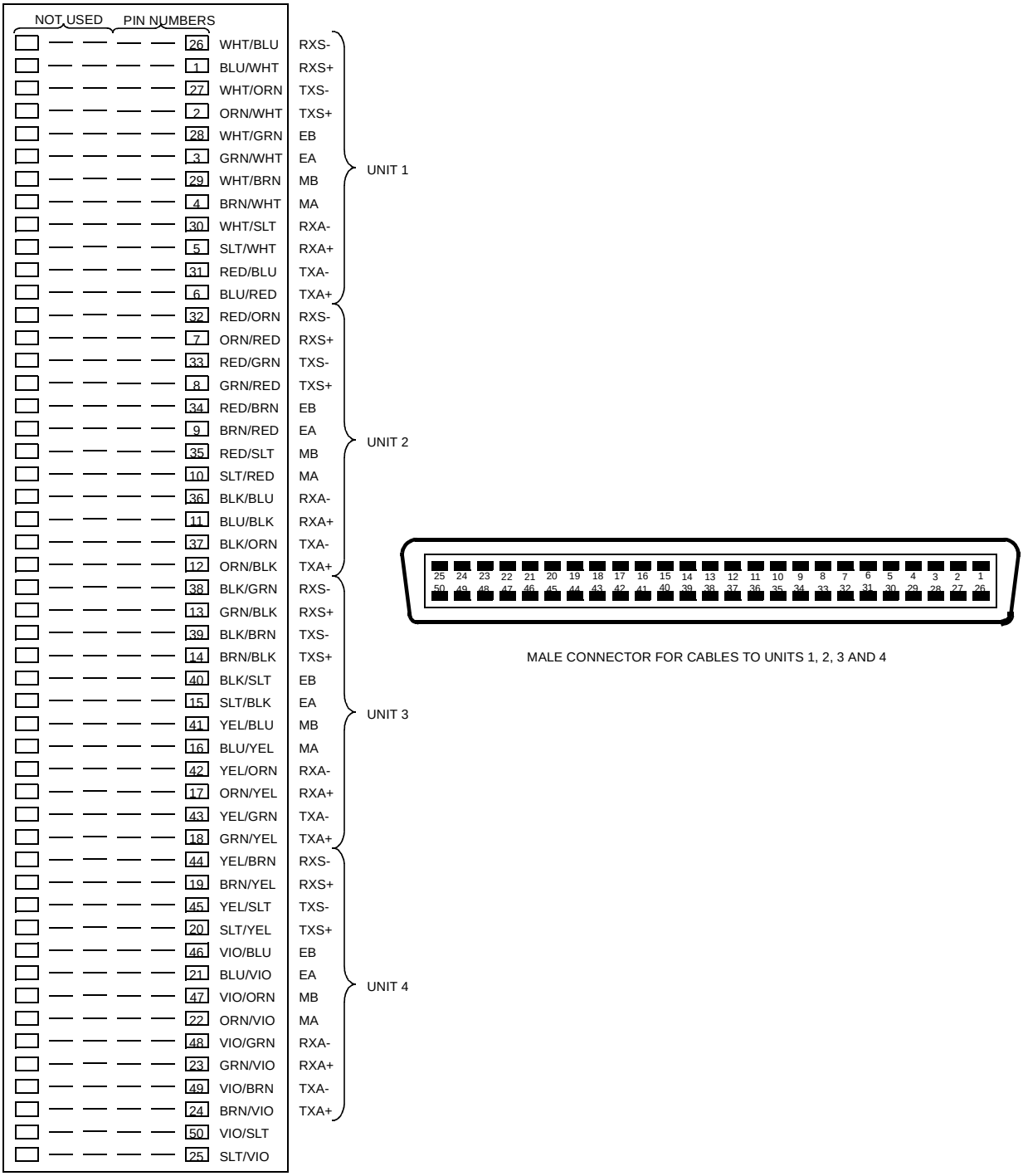


Figure 7-33 SWITCH (RNT) PUNCH BLOCK

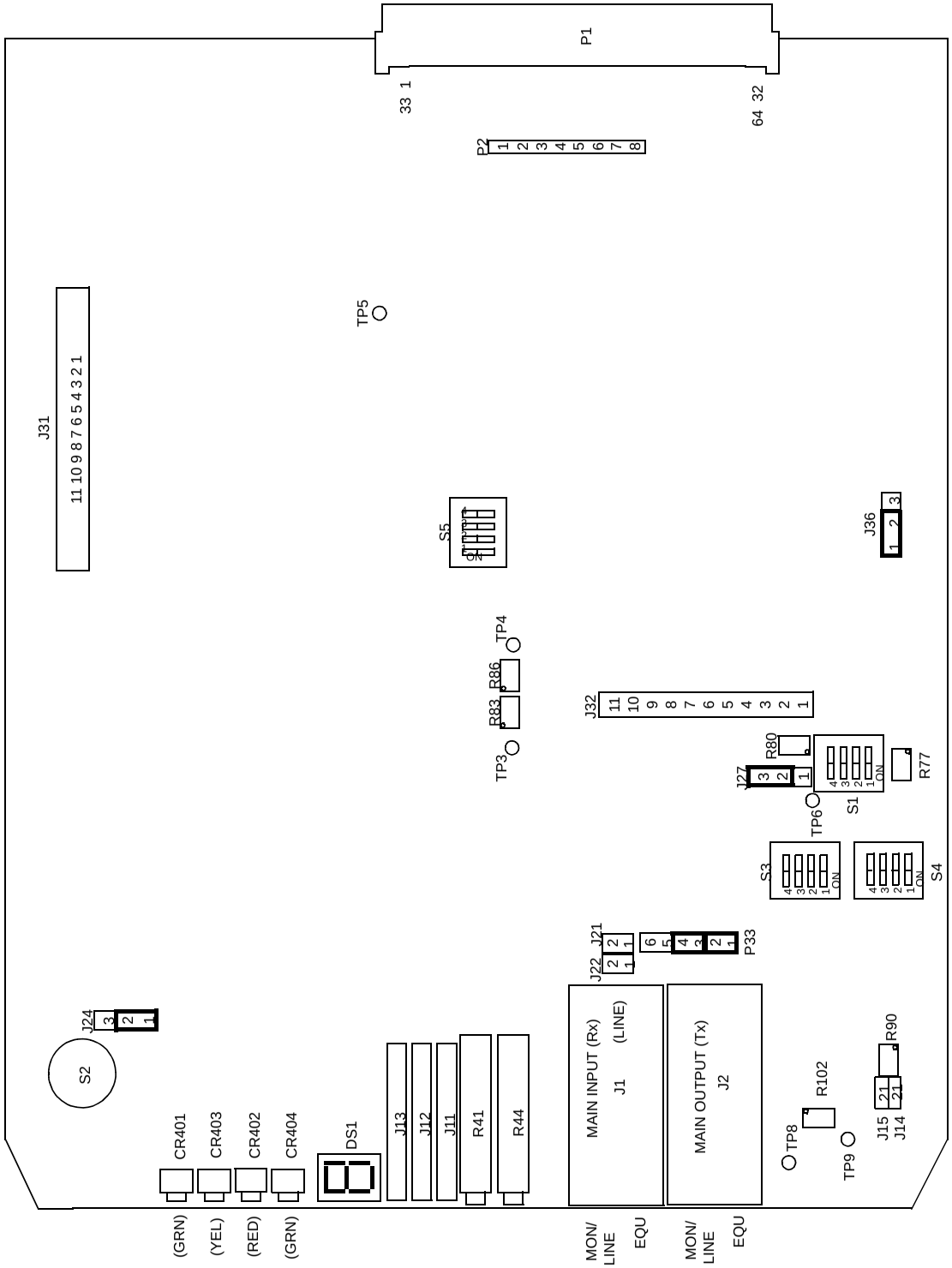


Figure 7-34 CIM ALIGNMENT POINTS

SECTION 8 SERVICING

8.1 INTRODUCTION

8.1.1 PERIODIC CHECKS

This repeater should be put on a regular maintenance schedule and an accurate performance record maintained. Important checks are receiver sensitivity and transmitter frequency, modulation, and power output. It is recommended that repeater performance be checked regularly even though periodic checks are not specifically required by the FCC.

8.1.2 SURFACE-MOUNTED COMPONENTS

A large number of the components used in this repeater are the surface-mounted type. Since these components are relatively small in size and are soldered directly to the PC board, care must be used when they are replaced to prevent damage to the component or PC board. Surface-mounted components should not be reused since they may be damaged by the unsoldering process. For more information on replacing surface-mounted components, refer to the Surface-Mounted Device Handbook, Part No. 001-0576-002.

8.1.3 SCHEMATIC DIAGRAMS AND COMPONENT LAYOUTS

Schematic diagrams and component layouts of the PC boards used in this repeater are located in Section 10. A component locator guide is also provided for both the schematic and board layouts to aid in component location.

8.1.4 REPLACEMENT PARTS LIST

A replacement parts list containing all the parts used in this repeater is located in Section 9. Parts are listed alpha numerically according to designator. For information on ordering parts, refer to Section 1.10.

8.1.5 TCXO MODULES NOT SERVICEABLE

Transmit or Receive TCXOs are not field serviceable because if a part is changed, a factory recalibration must be performed to ensure that it stays within its ±1 PPM tolerance.

8.2 SYNTHESIZER SERVICING

8.2.1 INTRODUCTION

Synthesizer malfunctions can be caused by no VCO output, or the VCO is unlocked. The VCO can be unlocked due to a bad synthesizer chip, an incomplete synthesizer phase-lock loop, or because the synthesizer chip is programmed incorrectly.

To make certain that the synthesizer chip is receiving programming data, pins 17, 18 and 19 of the chip should be monitored during programming. Pin 17 ($\overline{\text{Enable}}$) will go from a high to a low level. Pin 18 (Clock) will go from low to high in narrow pulses. Pin 19 (Data) goes from high to low with wider data pulses.

When the VCO is locked, the lock detect line of the synthesizer pin 2 is high with very narrow negative-going pulses. These pulses become wider when the VCO is out of lock. When this unlock condition exists either in the Exciter VCO or the Receiver VCO, it is relayed by the RF Interface board and is detected by the MPC via the RF Data lines. The MPC then does not allow the transmitter to key and the receiver cannot unsquelch.

When the VCO is unlocked, the f_R and f_V inputs to the phase detector are not in phase (refer to Sections 6.1.12 and 6.2.5). The phase detector in the synthesizer then causes the VCO control voltage to go to the high or low end of its operating range (0 or 9V). This in turn causes the VCO to oscillate at the high or low end of its frequency range.

As shown in Figures 6-1 and 6-4 a loop is formed by the VCO, buffer, frequency input (F_{IN}) and the phase detector output (PD OUT). Therefore, if any of these components begin to malfunction, improper signals appear throughout the loop. However, correct operation of the counters can still be verified by measuring the input and output frequencies to check the divide number.

Proceed as follows to check the input and output signal of the synthesizer modules to determine if they are operating properly.

8.2.2 TCXO MODULE

Check the signal at TCXO, pin 5. It should be 17.5 MHz for Y201 and Y401 at a level of approximately 3V P-P. If the TCXO is defective, it is not serviceable and must be replaced with a new unit as described in Section 8.1.5.

Measure the signal at pin 20 (Ref In) of the synthesizer chip. It will be approximately 1V P-P. If the signal is low here, the TCXO buffer circuit may be defective.

8.2.3 VOLTAGE CONTROLLED OSCILLATOR (VCO)

Check for VCO output signal with a high impedance RF voltmeter. If there is no output signal, or if the frequency is greatly off, the VCO is defective.

Next, monitor the signal level at pin 11 (F In) of the synthesizer chip. If the signal is less than 100 mV P-P, the VCO buffer is defective.

Lock Detector

When the VCO is locked on frequency, the waveform at pin 2 (Lock Det) should be as follows. When the VCO is unlocked, the negative-going pulses should be much wider than those shown in Figure 8-1. If the lock detect circuit is operating properly, check prescaler input pin 11 (F In).

The operation of the N and A counters can be observed by monitoring pins 16 and 19. Pin 16 (f_V) equals fin ÷ (64N+A) = 12.5 kHz if the synthesizer is locked. Pin 9 is the modulus control signal.

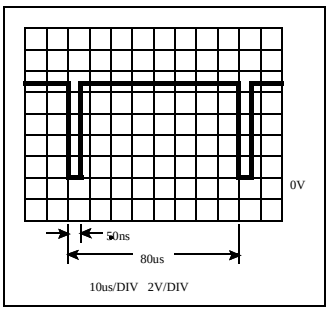


Figure 8-1 LOCK DETECT WAVEFORM

Modulus Control Signal

4. The frequency of the modulus control signal on TEST 1, pin 9 should be equal to the N counter output frequency (either in or out of lock). When the VCO is in lock, this frequency should be 12.5 kHz.

5. The duty cycle of the modulus control signal determines the divide number of the prescaler. The duty cycle (T1 ÷ T2) should be as follows:

   T1 ÷ T2 = A Cntr Div No ÷ N Cntr Div No
   T2 = 80 µs when locked.

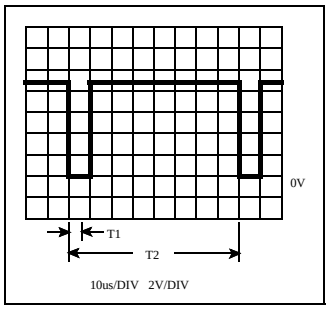


Figure 8-2 MODULUS CONTROL WAVEFORM

If the modulus control signal is not correct, the synthesizer may be defective or the logic may not be programming the correct divide number.

8.2.4 INTERNAL PRESCALER

Checking Prescaler Divide Number

The prescaler divide number can be checked by measuring the input and output frequencies. The prescaler divide number can be calculated as follows. (A and N counter divide numbers are calculated as described in Section 8.2.5.)

Prescaler Divide Number =
64 + (A Cntr Div No ÷ N Cntr Div No)

Example: Channel 300 (receive)

Prescaler Div No = 64 + (45 ÷ 950) = 64.0474

Measure the prescaler input frequency at f_{in}, pin 11. Then measure the output frequency at TEST 2, pin 13 and calculate the divide number. If the VCO is not locked on frequency, the divide number should still be correct. The measured frequencies may not be exactly as calculated due to counter accuracy and resolution limitations.

NOTE: The counter should be connected to a high stability reference oscillator.

Example: Channel 300, VCO locked on frequency

760.5375 MHz (pin 11) ÷ 11.8746 (pin 13) = 64.0474

8.2.5 CALCULATING "N " AND "A " COUNTER DIVIDE NUMBERS

"N" Counter

N Counter Divide Number =
Integer (VCO Freq. (MHz) ÷ 0.8)

Example: Channel 300 (receive)

VCO freq = 813.4875 - 52.95 = 760.5375 MHz

N Cntr Div No = 760.5375 ÷ 0.8 = 950.67188

Integer (whole no.) of 950.67188 = **950**

Example: Channel 300 (transmit)

N Cntr Div No = 858.4875 ÷ 0.8 = 1073.1094

Integer (whole no.) of 1073.1094 = **1073**

"A" Counter

A Counter Divide Number =
(VCO freq (MHz) ÷ .0125) - (N Cntr Div No x 64)

Example: Channel 300 (receive)

A Cntr Div No = (760.5375 ÷ .0125) - (950 x 64)
= 60,843 - 60,800
= **43**

Example: Channel 300 (transmit)

A Cntr Div No = (858.4875 ÷ .0125) - (1073 x 64)
= 68,679 - 68,672
= **7**

8.3 RECEIVER SERVICING

To isolate a receiver problem to a defective section, start by checking the DC voltages shown in Section 6.5.6 and on the schematic diagram (Section 10). If that does not indicate the problem, perform the performance tests in Section 7.1 to isolate the problem. If the synthesizer is out of lock, the receiver is also nonfunctional because the first injection and IF signals will be incorrect.

8.4 TRANSMITTER SERVICING

To isolate a transmitter problem to a defective section, start by checking the DC voltages shown in Sections 6.5.4 and 6.5.5 and on the schematic diagram (Section 10). If that does not indicate the problem, perform the Performance Tests in Section 7.2, 7.3 and 7.4 to isolate the problem. If the synthesizer is out of lock, the Exciter is also nonfunctional because the software will not allow the repeater to transmit.

8.5 POWER SUPPLY SERVICING

The power supply is a switch mode type with very high voltages. It is highly recommended that the power supply be returned to the factory for servicing (see Section 1.9). A parts list, schematic and component layout are provided for those customers that desire to do their own repairs (see Sections 9 and 10).

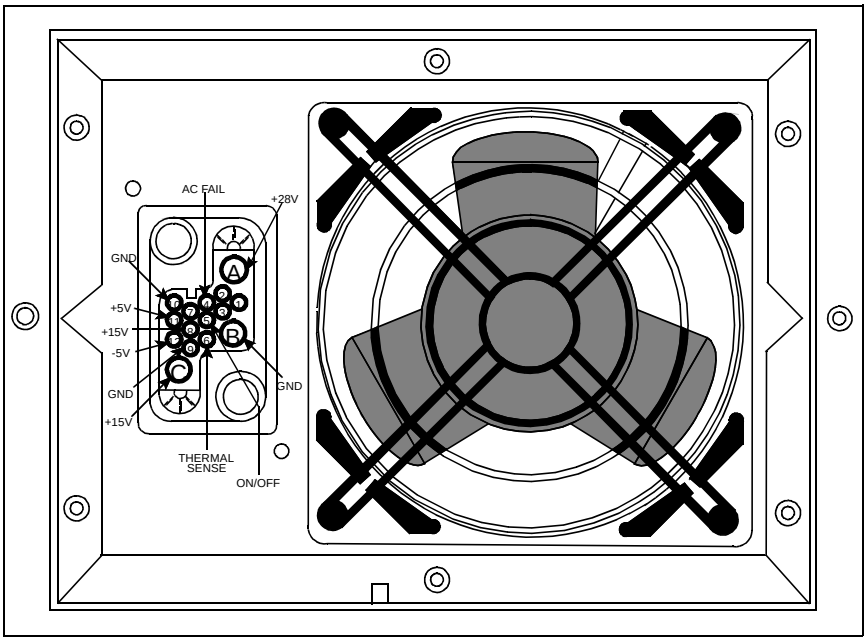


Figure 8-3 POWER SUPPLY FRONT VIEW

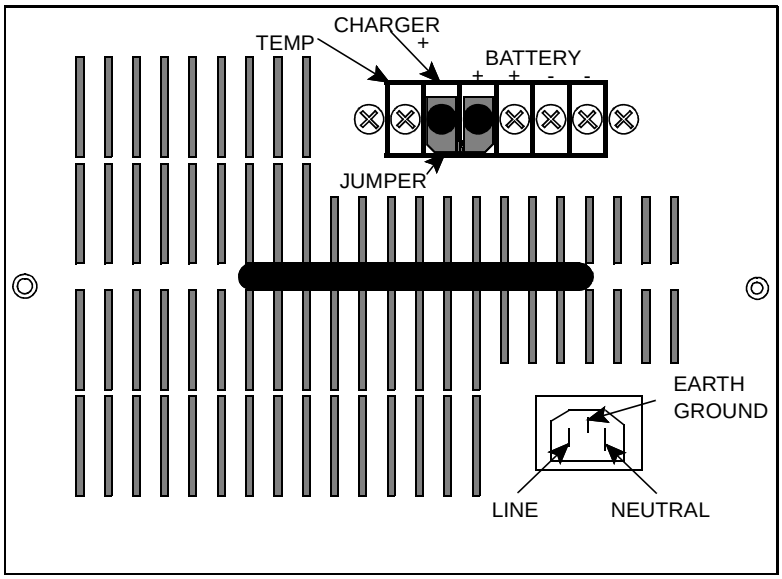


Figure 8-4 POWER SUPPLY FRONT VIEW

Standby Battery Jack

This provides a connection point for a +24V DC standby battery. Current is drawn from the battery only when the repeater enable line is on and AC has failed, or no AC is connected. A trickle charger can be jumpered in to charge the battery when AC returns. The charger jumper is removed when a separate battery charger is used (see Figure 8-3). The standby battery connection to the power supply must be ordered installed from the factory.
NOTE: A small amount (<30 mA) of current is drawn from the batteries with the repeater off. If the repeater is going to be turned off for more than one week (with good batteries connected) the fuse should be removed from the DC cable harness.

8.5.1 VOLTAGE CHECKS

Secondary voltages can be checked at the power supply connector with the power supply removed from the repeater. First the on/off line must be grounded (pin 5 to ground) then check the supply voltages (see Figure). If voltages are absent the supply must be sent to the E.F. Johnson Company.

8.6 CHIP COMPONENT IDENTIFICATION

8.6.1 CERAMIC CHIP CAPACITORS (510-36XX-XXX)

Ceramic chip capacitors are identified using either an American or Japanese EIA standard. The values for both standards are shown in Table 8-1.

American EIA Standard

The America EIA Standard uses a single letter or number to indicate the value, and the color of this letter or number to indicate the multiplier.

Japanese EIA Standard

The Japanese EIA Standard uses a letter to indicate the value followed by a number to indicate the multiplier.

Example: 15 pF capacitor

American - Single Black "E"
Japanese -"E1"

The Japanese EIA Standard may also utilize a bar to indicate the temperature coefficient.

Example: $\overline{A2}$ - 100 pF NPO

XX = NPO $\overline{XX}$ = N150 $X\overline{X}$ = N220

$\underline{XX}$ = N330 $\underline{X}X$ = N470 $X\underline{X}$ = N750

$\underline{|}XX$ = X7R

8.6.2 TANTALUM CHIP CAPACITORS (510-26XX-XXX)

Tantalum chip capacitor identification varies with vendor and physical size. The positive (+) end is usually indicated by a colored board or beveled edge. The value and voltage may be indicated by printing on the capacitor or by using a special code.

8.6.3 CHIP INDUCTORS (542-9000-XXX)

Three colored dots are used to indicate the value of chip inductors. The two dots on the left side indicate the first and second digits of the value in nano-Henries, and the single dot on the right side indicates the multiplier (see Table 8-2).

Example: Dots - Brown-Black-Red

10 nH x 100 = 1000 nH (1.0 μH)

The last three digits of the part number are also the value and multiplier. The multiplier digits are shown in Table 8-2.

8.6.4 CHIP RESISTORS

The value of chip resistors is indicated by a number printed on the resistor. A 3-digit number is used to identify ±5% and ±10% resistors, and a 4-digit number is used to identify ±1% resistors.

The 3-digit number used to identify ±5% and ±10% resistors corresponds to the last 3-digits of the E.F. Johnson part number. This number is derived as shown.

Example:

273 27k ohm

339 3.3 ohm

Some resistors with a ±1% tolerance are identified by a 4-digit number and others may not have a marking. When identified with a 4-digit number, the first three digits are the value and the fourth is the multiplier.

Example: 57615.76k ohm

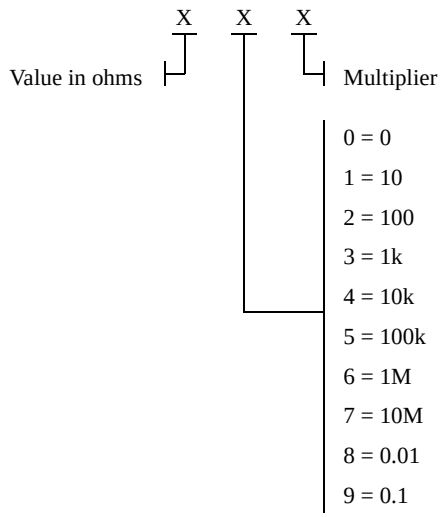
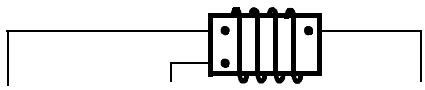


Figure 8-5 3-DIGIT RESISTOR

Table 8-1 CERAMIC CHIP CAP IDENTIFICATION

American EIA Standard		Japanese EIA Standard	
First Letter/ Number	**Value (pF)**	**First Letter/ Number**	**Value (pF)**
A	10	A	1.0
B	11	B	1.1
C	12	C	1.2
D	13	D	1.3
E	15	E	1.5
H	16	F	1.6
I	18	G	1.8
J	20	H	2.0
K	22	J	2.2
L	24	K	2.4
N	27	L	2.7
O	30	M	3.0
R	33	N	3.3
S	36	P	3.6
T	39	Q	3.9
V	43	R	4.3
W	47	S	4.7
X	51	T	5.1
Y	56	U	5.6
Z	62	V	6.2
3	68	W	6.8
4	75	X	7.5
7	82	Y	8.2
9	91	Z	9.1
Color	**Multiplier**	**Second Number**	**Multiplier**
Orange	0.1	0	1
Black	1	1	10
Green	10	2	100
Blue	100	3	1000
Violet	1000	4	10,000
Red	10,000	5	100,000

Table 8-2 CHIP INDUCTOR IDENTIFICATION



Color	1st Digit	2nd Digit	Multiplier (Last PN Digit)
Black	0	0	1 (7)
Brown	1	1	10 (8)
Red	2	2	100 (9)
Orange	3	3	1000 (0)
Yellow	4	4	10,000 (1)
Green	5	5	100,000 (2)
Blue	6	6	---
Violet	7	7	---
Gray	8	8	---
White	9	9	0.1 (6)

8.6.5 CHIP TRANSISTORS AND DIODES

Surface mounted transistors and diodes are identified by a special number that is shown in a (see Table 8-2).

8.7 BERYLLIUM PRODUCT WARNING

Q501, Q502, Q503, R504, R505 and R685 in the Power Amplifier contain Beryllium (BeO). Inhalation of dust or fumes may cause serious chronic lung disease. Refer to the Material Safety Data Sheets for further details.

8.8 GRAFOIL REPLACEMENT PROCEDURE

When replacing a device that uses Grafoil for the thermal interface, the Grafoil must be replaced. The old Grafoil must be completely removed from the heatsink. To avoid scuffing the heatsink a plastic scraper (e.g. tuning tool) should be used to remove the old Grafoil.

SECTION 9 PARTS LIST

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
	800 MHz MULTI-NET 75W REPEATER PART NO. 242-2008-132	
A 100	800 MHz 75W repeater assem	023-2008-232
U 110	FSK modem 7911 28-DIP	544-3988-004
	800 MHz 75W REPEATER PART NO. 242-2008-232	
A 003	800 MHz 75W PA/RFIB assem	023-2008-932
A 006	Receive/Exciter Module	023-2008-832
A 010	Power Supply	023-2000-800
HW001	6-32 machine panhead	575-1606-012
MP033	PA hold down bracket	017-2210-032
PA001	Main Processor Card assem**	023-2000-310
PA002	Main Audio Card assem**	023-2000-320
PA003	Interface Alarm Card assem**	023-2000-350
PA004	Repeater enclosure assembly	023-2000-200
W 013	AC power cord 6’ 7"	597-1001-013
	**Requires Application Engineering authorization to purchase.	
	800 MHz MULTI-NET 175W REPEATER PART NO. 242-2008-134	
A 100	800 MHz 75W repeater assem	023-2008-234
U 110	FSK modem 7911 28-DIP	544-3988-004
	800 MHz MULTI-NET 175W REPEATER PART NO. 242-2008-234	
A 003	800 MHz 175W PA/RFIB	023-2008-934
A 006	Receiver/Exciter module	023-2008-832
A 010	Power supply	023-2000-800
HW001	6-32 machine panhead	575-1606-012
MP033	PA hold down bracket	017-2210-032
PA001	Main Processor Card assem**	023-2000-310
PA002	Main Audio Card assem**	023-2000-320
PA003	Interface Alarm Card assem**	023-2000-350
PA004	Repeater enclosure assembly	023-2000-200
W 013	AC power cord 6’ 7"	597-1001-013
	**Requires Application Engineering authorization to purchase.	
	75W PA/RFIB ASSEMBLY PART NO. 023-2008-942	
A 002	895 MHz circulator < 250W	585-0590-005
A 004	PA - Rx/Tx 20-cond ribbon	023-2000-190
A 005	PA - Rx/Tx 20-cond ribbon	023-2000-190
A 008	Cable assembly	416-0614-001
A 009	PA RF input coax assembly	597-3002-031
A 010	Fwd/Rev Power Detector	023-2008-680
A 011	800 MHz LPF Rptr to Final	023-2008-630
C 001	1000 pF ±20% 1kV feedthru	510-3149-102
C 002	1000 pF ±20% 1kV feedthru	510-3149-102
C 003	1000 pF ±20% 1kV feedthru	510-3149-102
C 004	1000 pF ±20% 1kV feedthru	510-3149-102
C 005	1000 pF ±20% 1kV feedthru	510-3149-102
C 006	1000 pF ±20% 1kV feedthru	510-3149-102
C 007	1000 pF ±20% 1kV feedthru	510-3149-102
C 008	1000 pF ±20% 1kV feedthru	510-3149-102
C 009	1000 pF ±20% 1kV feedthru	510-3149-102
C 010	1000 pF ±20% 1kV feedthru	510-3149-102
C 011	1000 pF ±20% 1kV feedthru	510-3149-102
C 012	1000 pF ±20% 1kV feedthru	510-3149-102
C 013	1000 pF ±20% 1kV feedthru	510-3149-102
C 523	12 pF 250V mini mica	510-0019-120
C 524	12 pF 250V mini mica	510-0019-120
C 525	22 pF 250V mini mica	510-0019-220
C 526	22 pF 250V mini mica	510-0019-220
C 527	1.3-5.4 pF ±20% vert mt	187-0103-175
C 586	5 pF 250V mini mica	510-0019-509
C 587	5 pF 250V mini mica	510-0019-509
EP500	RF power detector jumper	016-2228-015
EP509	Ferrite bead SMD-1233	517-2503-010

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
HW003	5/8-24x0.094 hex nut NPB	560-9079-028
HW004	5/8x0.02 lockwasher int CPS	596-9119-028
J 001	2-pin lock receptacle #22	515-9032-232
PA001	75W PA mechanical assem	023-2008-742
PA008	RF Interface board assembly	023-2008-110
PA009	PA assembly	023-2008-540
Q 501*	30W 24V 900 MHz MRF-894	576-0004-821
Q 502*	60W 24V 800 MHz MRF-898	576-0004-820
Q 503*	60W 24V 800 MHz MRF-898	576-0004-820
R 508*	100 ohm 20W flange mount	569-5001-001
R 509*	100 ohm 100W flange mount	569-5001-002
R 685*	50 ohm 250W flange mt load	569-5001-003

800 MHz 175W REPEATER ASSEMBLY
PART NO. 023-2008-934

A 002	895 MHz circulator <250W	585-0590-005
A 004	PA-Rx/Tx 20-cond rbn cable	023-2000-190
A 005	PA-Rx/Tx 20-cond rbn cable	023-2000-190
A 008	N-ST BK jack/conn cable	416-0614-001
A 009	PA RF input coax assembly	597-3002-031
A 010	Fwd/Rev power detect assem	023-2008-680
A 011	800 MHz LPF assembly	023-2008-630
PA001	PA mechanical	023-2008-734
PA008	RF Interface board assembly	023-2008-110
PA009	800 MHz 175W PA assembly	023-2008-520
C 001	1000 pF ±20% 1kV feedthru	510-3149-102
C 002	1000 pF ±20% 1kV feedthru	510-3149-102
C 003	1000 pF ±20% 1kV feedthru	510-3149-102
C 004	1000 pF ±20% 1kV feedthru	510-3149-102
C 005	1000 pF ±20% 1kV feedthru	510-3149-102
C 006	1000 pF ±20% 1kV feedthru	510-3149-102
C 007	1000 pF ±20% 1kV feedthru	510-3149-102
C 008	1000 pF ±20% 1kV feedthru	510-3149-102
C 009	1000 pF ±20% 1kV feedthru	510-3149-102
C 010	1000 pF ±20% 1kV feedthru	510-3149-102
C 011	1000 pF ±20% 1kV feedthru	510-3149-102
C 012	1000 pF ±20% 1kV feedthru	510-3149-102
C 013	1000 pF ±20% 1kV feedthru	510-3149-102
EP500	Jumper	016-2228-015

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
HW003	5/8-24x0.094 hex nut	560-9079-028
HW004	5/8x0.02 lockwasher int	596-9119-028
J 001	2-pin receptacle lock	515-9032-232
J 002	2-pin receptacle lock	515-9032-232
Q 502[1]	60W 800 MHz 24V MRF898	576-0004-820
Q 701[1]	60W 800 MHz 24V MRF898	576-0004-820
Q 702[1]	60W 800 MHz 24V MRF898	576-0004-820
Q 703[1]	60W 800 MHz 24V MRF898	576-0004-820
Q 704[1]	60W 800 MHz 24V MRF898	576-0004-820
R 685[1]	50 ohm 250W flange mt load	569-5001-003
R 701[1]	100 ohm 20W flange mount	569-5001-001
R 702[1]	100 ohm 20W flange mount	569-5001-001
R 703[1]	100 ohm 100W flange mount	569-5001-002
R 716[1]	100 ohm 20W flange mount	569-5001-001
R 717[1]	100 ohm 100W flange mount	569-5001-002
R 730[1]	100 ohm 100W flange mount	569-5001-002
U 501	20W 870 MHz power module	544-4001-127

REPEATER ENCLOSURE ASSEMBLY
PART NO. 023-2000-200

A 004	Shelf power harness assembly	023-2000-165
A 005	High speed data bus harness	023-2000-170
A 006	Input/Output harness assem	023-2000-175
A 007	Alarm harness assembly	023-2000-180
A 008	RF input harness assembly	023-2000-185
A 009	Controller backplane card	023-2000-210
A 010	External connector board	023-2000-220
A 011	Power supply filter board	023-2000-250
CH017	Chassis	017-2210-080
EP001	Ferrite bd 1.122x1.125x0.543	517-2002-008
EP002	Ferrite bd 0.687x1.125x0.375	517-2002-009
EP010	3/8" heat shrink tubing	042-0241-556
EP011	1/2" heat shrink tubing	042-0241-557
HW013	6-32 machine panhead philips	575-1606-014
HW014	6-32 machine panhead philips	575-1606-012
HW016	8-32 machine panhead phil	575-1608-012
HW017	10-32 machine panhead phil	575-1610-016
HW018	6-19 panhead phil ZPS screw	575-5606-008

1 **DANGER** Beryllium Product. Inhalation of dust or fumes may cause serious chronic lung disease

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
HW019	6-32 machine flathead philips	575-8206-012
HW020	6-32 x 0.094 nut	560-1106-010
HW021	8-32 socket head shldr screw	575-9078-106
HW022	8 x 0.032 flat washer NPB	596-2408-012
HW023	#10 flat washer NPB	596-1410-016
HW024	1/2" cable clamp	572-0001-007
HW025	Ratcheting flat wire	572-0011-005
HW026	Floating connector shield	018-1007-028
HW027	Floating connector cushion	018-1132-150
HW029	Speed nut 0.093 stud	537-0002-004
HW030	4-40 shield screw	575-9078-105
HW031	Lens, adhesive	574-3002-115
HW032	6-32 machine panhead philips	575-1606-024
HW033	6 x 0.018 lockwasher	596-1106-009
HW036	High vinyl foot	574-1004-003
J 010	Banana jack assembly .166	108-2302-621
J 011	Banana jack assembly .166	108-2303-621
J 012	Banana jack assembly .166	108-2301-621
MP001	PA floating connector bracket	017-2210-099
MP012	8-32 x 1.15 spacer 0.375	013-1723-221
MP013	Guide pin shield	013-1723-220
MP015	Chassis top cover	017-2210-070
MP017	Door lock rod	013-1723-225
MP018	Mounting ears	017-2210-085
MP019	Door lock cam	017-2210-110
MP020	Front door lens	032-0758-025
MP021	PA slide	032-0758-015
MP022	Front door	032-0758-020
MP024	Slide lock cam	537-9007-012
MP025	Card guide 4.5"	574-9015-006
MP026	PA conn floating plate	017-2226-020
MP028	Flexible grommet	574-0001-025
MP029	Flexible grommet	574-0001-025
MP030	Spacer	013-1723-228
MP031	Spacer	013-1723-229
MP032	Dowel pin guide	013-1723-230
NP001	Nameplate E.F. Johnson	559-5861-163

TRANSCEIVER MECHANICAL
PART NO. 023-2000-205

CH252	Transceiver housing	015-0902-010
EP252	0.156 OD RF shield gasket	574-3002-036
HW272	6-32 pan torx ZPS	575-0006-010
HW273	6-32 machine panhead philips	575-1606-016
MP253	Transceiver deck cover	015-0902-015

CONTROLLER BACKPLANE CARD
PART NO. 023-2000-210

F 001	4 Amp 250V submin fuse	534-0017-020
F 002	4 Amp 250V submin fuse	534-0017-020
F 003	1 Amp 250V submin fuse	534-0017-014
FH001	Fuse holder	534-0017-001
FH002	Fuse holder	534-0017-001
FH003	Fuse holder	534-0017-001
HW012	Polarizing key box cont	515-7109-010
J 001	34 pin latch ejection header	515-9031-400
J 002	34 pin latch ejection header	515-9031-400
MP001	Round swage spacer 0.5"	312-2483-216
MP002	Round swage spacer 0.75"	312-2483-224
P 001	64-pin DIN female straight	515-7082-201
P 002	32-pin DIN female straight	515-7082-200
P 003	64-pin DIN female straight	515-7082-201
P 004	32-pin DIN female straight	515-7082-200
P 005	64-pin DIN female straight	515-7082-201
P 006	32-pin DIN female straight	515-7082-200
P 007	64-pin DIN female straight	515-7082-201
P 008	32-pin DIN female straight	515-7082-200
P 009	32-pin DIN female straight	515-7082-200
P 010	26-pin locking straight header	515-9031-397
P 011	6-pin friction lock conn	515-9031-205
P 012	64-pin DIN female straight	515-7082-201
P 013	32-pin DIN female straight	515-7082-200
P 014	64-pin DIN female straight	515-7082-201
P 015	32-pin DIN female straight	515-7082-200
P 016	64-pin DIN female straight	515-7082-201
P 017	32-pin DIN female straight	515-7082-200
P 018	64-pin DIN female straight	515-7082-201
PC001	PC board	035-2000-210

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
	EXTERNAL CONNECTOR BOARD PART NO. 023-2000-220	
HW001	6-32 ss pem fastener	560-9106-010
HW002	Polarizing key box cnt	515-7109-010
J 001	26-pos terminal block PC mt	515-7110-426
J 002	34-pos terminal block PC mt	515-7110-434
J 003	34-pos latch ejection header	515-9031-400
J 004	8-pos modular jack	515-2006-046
J 005	8-pos modular jack	515-2006-046
MP001	9800 insulator	018-1132-018
NP001	External connector label	559-0069-060
P 001	26-pin locking straight header	515-9031-397
P 002	8-pin straight locking header	515-9031-207
PC001	PC board	035-2000-220
	POWER SUPPLY FILTER BOARD PART NO. 023-2000-250	
C 001	2200 µF 35V aluminum elect	510-4075-222
C 002	2200 µF 35V aluminum elect	510-4075-222
C 003	2200 µF 35V aluminum elect	510-4075-222
EP020	Ferrite bead	517-2002-009
EP021	Ferrite bead	517-2002-009
MP001	Round tapped swage spacer	312-2493-212
MP002	Round tapped swage spacer	312-2493-212
PC001	PC board	035-2000-250
	RF INTERFACE BOARD PART NO. 023-2008-110	
C 101	.1 µF ±10% X7R chip	510-3606-104
C 102	2.2 µF 20V tantalum SMD	510-2626-229
C 103	4.7 µF 16V tantalum SMD	510-2625-479
C 104	.1 µF ±10% X7R 1206 chip	510-3606-104
C 105	39 pF ±5% NPO 1206 chip	510-3602-390
C 107	2.2 µF 20V tantalum SMD	510-2626-229
C 108	.018 µF ±10% X7R 0805 chip	510-3605-183
C 109	.001 µF ±5% NPO 1206 chip	510-3602-102
C 110	.1 µF ±10% X7R 1206 chip	510-3606-104
C 111	.047 µF ±10% X7R 1206 chip	510-3606-473
C 112	1 µF 35V tantalum SMD	510-2628-109
C 113	.047 µF ±10% X7R 1206 chip	510-3606-473
C 114	1 µF 35V tantalum SMD	510-2628-109
C 115	.047 µF ±10% X7R 1206 chip	510-3606-473
C 116	.01 µF ±10% X7R 1206 chip	510-3606-103
C 117	1000 µF 50V axial low temp	510-4076-102
C 119	.1 µF ±10% X7R 1206 chip	510-3606-104
C 120	.1 µF ±10% X7R 1206 chip	510-3606-104
C 125	.01 µF ±10% X7R 1206 chip	510-3606-103
C 126	.018 µF ±10% X7R 0805 chip	510-3605-183
C 130	.1 µF ±10% X7R 1206 chip	510-3606-104
C 132	.001 µF ±5% NPO 1206 chip	510-3602-102
C 135	.001 µF ±5% NPO 1206 chip	510-3602-102
C 138	.001 µF ±5% NPO 1206 chip	510-3602-102
C 141	.001 µF ±5% NPO 1206 chip	510-3602-102
C 143	.1 µF ±10% X7R 1206 chip	510-3606-104
C 149	.1 µF ±10% X7R 1206 chip	510-3606-104
C 150	.001 µF ±5% NPO 1206 chip	510-3602-102
CR101	Switching SOT-23	523-1504-002
CR103	3.9V zener SOT-23	523-2016-399
CR104	5.1V zener SOT-23	523-2016-519
CR107	5.1V zener SOT-23	523-2016-519
CR108	5.1V zener SOT-23	523-2016-519
CR109	5.1V zener SOT-23	523-2016-519
CR110	5.1V zener SOT-23	523-2016-519
CR111	Dual switching common-cath	523-1504-022
EP101	Terminal lug 2104-06	586-0005-106
EP102	Terminal lug 2104-06	586-0005-106
EP103	Terminal lug 2104-06	586-0005-106
EP104	Terminal lug 2104-06	586-0005-106
EP105	Terminal lug 2104-06	586-0005-106
F 101	2A 250V AC sub-min	534-0017-017
F 102	2A 250V AC sub-min	534-0017-017
FH101	Fuse holder PC mount	534-1017-001
FH102	Fuse holder PC mount	534-1017-001
HW105	Polarizing key box cnt	515-7109-010
HW106	Polarizing key box cnt	515-7109-010
HW247	6-32 machine panhead philips	575-1606-012

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
J 101	36-pin right angle radial	515-0511-001
J 102	20-pin straight low profile	515-9031-376
J 103	20-pin straight low profile	515-9031-376
J 104	4-pin right angle header	515-9035-004
L 101	3 μH filter choke PC mount	542-5007-031
MP101	PA connector mounting shield	032-0758-028
P 101	Banana plug panel mount	108-0753-001
P 102	Banana plug panel mount	108-0753-001
P 103	Banana plug panel mount	108-0753-001
P 104	Banana plug panel mount	108-0753-001
P 105	Banana plug panel mount	108-0753-001
PC100	PC board	035-2008-110
Q 101	Si PNP low noise SOT-23	576-0003-657
Q 102	Si NPN SOT-23	576-0003-600
Q 103	PNP D-pak power	576-0002-603
Q 104	Si NPN low noise SOT-23	576-0003-657
Q 105	Si NPN amp SOT-23	576-0003-658
Q 106	Si NPN SOT-23	576-0003-600
Q 107	PNP D-pak power	576-0002-603
Q 108	Si NPN gen purp sw/amp	576-0001-300
R 045	100 ohm ±5% 1206 SMD	569-0115-101
R 046	100 ohm ±5% 1206 SMD	569-0115-101
R 048	1k ohm ±5% 1206 SMD	569-0115-102
R 049	Zero ohm ±5% 1206 SMD	569-0115-001
R 050	4.99k ohm ±1% 1206 SMD	569-0111-368
R 051	100 ohm ±5% 1206 SMD	569-0115-101
R 052	10k ohm ±5% 1206 SMD	569-0115-103
R 053	10k ohm ±5% 1206 SMD	569-0115-103
R 054	10k ohm ±5% 1206 SMD	569-0115-103
R 055	2.7k ohm ±5% 1206 SMD	569-0115-272
R 056	470k ohm ±5% 1206 SMD	569-0115-474
R 057	10k ohm ±5% 1206 SMD	569-0115-103
R 059	10k ohm ±5% 1206 SMD	569-0115-103
R 061	43k ohm ±5% 1206 SMD	569-0115-433
R 063	10k ohm ±5% 1206 SMD	569-0115-103
R 064	43k ohm ±5% 1206 SMD	569-0115-433
R 065	10k ohm ±5% 1206 SMD	569-0115-103
R 066	43k ohm ±5% 1206 SMD	569-0115-433
R 073	10k ohm ±5% 1206 SMD	569-0115-103
R 074	1k ohm ±5% 1206 SMD	569-0115-102
R 075	1k ohm ±5% 1206 SMD	569-0115-102
R 076	5k ohm single turn trimmer	562-0112-502
R 078	270k ohm ±5% 1206 SMD	569-0115-274
R 079	1k ohm ±1% 1206 SMD	569-0111-301
R 080	1k ohm ±1% 1206 SMD	569-0111-301
R 081	470 ohm ±5% 1206 SMD	569-0115-471
R 082	270k ohm ±5% 1206 SMD	569-0115-274
R 083	1k ohm ±1% 1206 SMD	569-0111-301
R 084	1k ohm ±1% 1206 SMD	569-0111-301
R 085	470 ohm ±5% 1206 SMD	569-0115-471
R 086	270k ohm ±5% 1206 SMD	569-0115-274
R 087	1k ohm ±1% 1206 SMD	569-0111-301
R 088	1k ohm ±1% 1206 SMD	569-0111-301
R 089	470 ohm ±5% 1206 SMD	569-0115-471
R 090	270k ohm ±5% 1206 SMD	569-0115-274
R 091	1k ohm ±1% 1206 SMD	569-0111-301
R 092	1k ohm ±1% 1206 SMD	569-0111-301
R 093	470 ohm ±5% 1206 SMD	569-0115-471
R 094	5.1k ohm ±5% 1206 SMD	569-0115-512
R 095	1k ohm ±5% 1206 SMD	569-0115-102
R 100	100 ohm ±5% 1206 SMD	569-0115-101
R 101	1k ohm ±5% 1206 SMD	569-0115-102
R 102	2.7k ohm ±5% 1206 SMD	569-0115-272
R 103	270k ohm ±5% 1206 SMD	569-0115-274
R 104	270k ohm ±5% 1206 SMD	569-0115-274
R 105	2.7k ohm ±5% 1206 SMD	569-0115-272
R 106	10k ohm ±5% 1206 SMD	569-0115-103
R 107	560 ohm ±5% 1206 SMD	569-0115-561
R 108	2.7k ohm ±5% 1206 SMD	569-0115-272
R 109	1k ohm ±5% 1206 SMD	569-0115-102
R 110	5.1k ohm ±5% 1206 SMD	569-0115-512
R 111	330 ohm ±5% 1206 SMD	569-0115-331
R 112	1k ohm ±5% 1206 SMD	569-0115-102
R 113	1.8k ohm ±5% 1206 SMD	569-0115-182
R 114	1.8k ohm ±5% 1206 SMD	569-0115-182
R 115	470 ohm ±5% 1206 SMD	569-0115-471
R 116	470 ohm ±5% 1206 SMD	569-0115-471
R 117	270 ohm ±5% 1206 SMD	569-0115-271
R 118	20k ohm ±1% 1206 SMD	569-0111-430
R 119	20k ohm ±1% 1206 SMD	569-0111-430
R 120	10k ohm ±1% 1206 SMD	569-0111-401
R 121	20k ohm ±1% 1206 SMD	569-0111-430
R 122	10k ohm ±1% 1206 SMD	569-0111-401
R 123	20k ohm ±1% 1206 SMD	569-0111-430
R 124	10k ohm ±1% 1206 SMD	569-0111-401
R 125	20k ohm ±1% 1206 SMD	569-0111-430
R 126	10k ohm ±1% 1206 SMD	569-0111-401
R 127	20k ohm ±1% 1206 SMD	569-0111-430

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
R 128	10k ohm ±1% 1206 SMD	569-0111-401
R 129	20k ohm ±1% 1206 SMD	569-0111-430
R 130	10k ohm ±1% 1206 SMD	569-0111-401
R 131	20k ohm ±1% 1206 SMD	569-0111-430
R 132	10k ohm ±1% 1206 SMD	569-0111-401
R 133	20k ohm ±1% 1206 SMD	569-0111-430
R 134	20k ohm ±1% 1206 SMD	569-0111-430
R 135	22k ohm ±5% 1206 SMD	569-0115-223
R 136	22k ohm ±5% 1206 SMD	569-0115-223
R 137	22k ohm ±5% 1206 SMD	569-0115-223
R 138	22k ohm ±5% 1206 SMD	569-0115-223
R 139	10k ohm ±5% 1206 SMD	569-0115-103
R 140	10k ohm ±5% 1206 SMD	569-0115-103
R 141	10k ohm ±5% 1206 SMD	569-0115-103
R 142	10k ohm ±5% 1206 SMD	569-0115-103
R 143	22k ohm ±5% 1206 SMD	569-0115-223
R 144	22k ohm ±5% 1206 SMD	569-0115-223
R 145	22k ohm ±5% 1206 SMD	569-0115-223
R 146	22k ohm ±5% 1206 SMD	569-0115-223
R 147	22k ohm ±5% 1206 SMD	569-0115-223
R 148	22k ohm ±5% 1206 SMD	569-0115-223
R 149	22k ohm ±5% 1206 SMD	569-0115-223
R 151	10k ohm ±5% 1206 SMD	569-0115-103
R 152	10k ohm ±5% 1206 SMD	569-0115-103
R 153	22k ohm ±5% 1206 SMD	569-0115-223
R 154	22k ohm ±5% 1206 SMD	569-0115-223
R 155	22k ohm ±5% 1206 SMD	569-0115-223
R 156	22k ohm ±5% 1206 SMD	569-0115-223
R 157	10k ohm ±5% 1206 SMD	569-0115-103
R 158	10k ohm ±5% 1206 SMD	569-0115-103
R 159	10k ohm ±5% 1206 SMD	569-0115-103
R 160	22k ohm ±5% 1206 SMD	569-0115-223
R 161	22k ohm ±5% 1206 SMD	569-0115-223
R 162	22k ohm ±5% 1206 SMD	569-0115-223
R 163	22k ohm ±5% 1206 SMD	569-0115-223
R 164	22k ohm ±5% 1206 SMD	569-0115-223
R 165	22k ohm ±5% 1206 SMD	569-0115-223
R 166	22k ohm ±5% 1206 SMD	569-0115-223
R 167	1k ohm ±1% 1206 SMD	569-0111-301
R 168	10k ohm ±5% 1206 SMD	569-0115-103
R 169	270k ohm ±5% 1206 SMD	569-0115-274
R 170	1k ohm ±1% 1206 SMD	569-0111-301
R 171	511 ohm ±1% 1206 SMD	569-0111-269
R 172	1k ohm ±5% 1206 SMD	569-0115-102
R 173	3.3k ohm ±5% 1206 SMD	569-0115-332
R 174	8.2k ohm ±5% 1206 SMD	569-0115-822
R 175	8.2k ohm ±5% 1206 SMD	569-0115-822
R 176	8.2k ohm ±5% 1206 SMD	569-0115-822
R 177	8.2k ohm ±5% 1206 SMD	569-0115-822
R 178	8.2k ohm ±5% 1206 SMD	569-0115-822
R 179	10k ohm ±5% 1206 SMD	569-0115-103
R 180	10k ohm ±5% 1206 SMD	569-0115-103
R 181	22 ohm ±5% 1206 SMD	569-0115-220
R 182	22 ohm ±5% 1206 SMD	569-0115-220
R 183	22 ohm ±5% 1206 SMD	569-0115-220
R 184	22 ohm ±5% 1206 SMD	569-0115-220
R 185	22k ohm ±5% 1206 SMD	569-0115-223
R 186	10k ohm ±5% 1206 SMD	569-0115-103
R 187	15k ohm ±5% 1206 SMD	569-0115-153
R 188	22 ohm ±5% 1206 SMD	569-0115-220
R 189	22 ohm ±5% 1206 SMD	569-0115-220
R 190	22 ohm ±5% 1206 SMD	569-0115-220
R 191	22 ohm ±5% 1206 SMD	569-0115-220
R 192	22k ohm ±5% 1206 SMD	569-0115-223
R 193	10k ohm ±5% 1206 SMD	569-0115-103
R 194	15k ohm ±5% 1206 SMD	569-0115-153
R 197	10k ohm ±5% 1206 SMD	569-0115-103
R 198	10k ohm ±5% 1206 SMD	569-0115-103
R 199	10k ohm ±5% 1206 SMD	569-0115-103
U 101	+5V regulator 78L05	544-2603-039
U 102	Dual op amp SOIC LM2904	544-2019-004
U 103	8-bit shift register MC14094	544-3016-094
U 104	8-chan mux 4051	544-3016-051
U 105	8-chan mux 4051	544-3016-051
U 106	8-chan mux 4051	544-3016-051
U 107	Dual op amp SOIC LM2904	544-2019-004
U 108	Dual op amp SOIC LM2904	544-2019-004
U 109	Quad op amp SOIC LM224	544-2020-014
U 110	Hex non-inv buffer 4050B	544-3016-050
U 111	Dual op amp SO-8 LM2904	544-2019-004
U 112	Quad op amp SOIC LM224	544-2020-014

RECEIVE/TRANSMIT MODULE
PART NO. 023-2008-832

PA002	Transceiver mechanical	023-2000-205
PA004	800 MHz Receiver	023-2008-200
PA005	800 MHz Exciter	023-2008-400
HW001	5/8-24 x 0.094 hex nut NPB	560-9079-028
HW002	5/8 x 0.02 int lockwasher CPS	596-9119-028
HW249	10-32 mach panhead phil ZPS	575-1610-020
HW250	#10 flat washer ZPS	596-1410-016
MP200	Transceiver pad	017-2210-105

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
	RECEIVE VCO 800 MHz PART NO. 023-2008-800	
C 803	1 pF 150V chip	510-3656-109
C 804	2.7 pF 150V chip	510-3656-279
C 805	.47 µF 16V tantalum SMD	510-2625-478
C 806	4.7 µF 10V tantalum SMD	510-2624-479
C 807	27 pF ±5% NPO 0805 chip	510-3601-270
C 808	27 pF ±5% NPO 0805 chip	510-3601-270
C 809	15 µF 20V tantalum SMD	510-2626-150
C 810	27 pF ±5% NPO 0805 chip	510-3601-270
C 811	27 pF ±5% NPO 0805 chip	510-3601-270
C 812	4.7 pF 150V chip	510-3656-479
C 813	6.8 pF 150V chip	510-3656-689
CR802	Varactor	523-1504-915
L 803	.039 µH inductor SMD	542-9001-397
L 804	.039 µH inductor SMD	542-9001-397
L 805	.039 µH inductor SMD	542-9001-397
PC800	PC board	035-2008-800
Q 801	Si NPN gen purp switch/amp	576-0001-300
Q 802	NPN UHF low noise SOT-23	576-0003-636
R 801	10 ohm ±5% 0805 chip	569-0105-100
R 802	3.6k ohm ±5% 0805 chip	569-0105-362
R 803	10 ohm ±5% 0805 chip	569-0105-100
R 804	4.7k ohm ±5% 0805 chip	569-0105-472
R 805	5.1k ohm ±5% 0805 chip	569-0105-512
R 806	6.2k ohm ±5% 0805 chip	569-0105-622
R 807	180 ohm ±5% 0805 SMD	569-0115-181
	RECEIVER PART NO. 023-2008-200	
A 006	800 MHz VCO	023-2008-800
A 201	RF input coax	023-2000-161
A 203	Receiver board top shield	023-2000-199
C 201	6.8 pF ±5% NPO 1206 chip	510-3602-689
C 202	6.2 pF ±5% NPO 1206 chip	510-3602-629
C 203	4.7 µF 16V tantalum SMD	510-2625-479
C 204	56 pF ±5% NPO 1206 chip	510-3602-560
C 205	6.8 pF ±5% NPO 1206 chip	510-3602-689
C 206	56 pF ±5% NPO 1206 chip	510-3602-560
C 207	6.2 pF ±5% NPO 1206 chip	510-3602-629
C 208	24 pF ±5% NPO 1206 chip	510-3602-240
C 209	10 pF ±5% NPO 1206 chip	510-3602-100
C 210	10 pF ±5% NPO 1206 chip	510-3602-100
C 211	.01 µF ±10% X7R chip	510-3606-103
C 212	.01 µF ±10% X7R chip	510-3606-103
C 213	4.7 µF 16V tantalum SMD	510-2625-479
C 214	10 pF ±5% NPO 1206 chip	510-3602-100
C 215	6.8 pF ±5% NPO 1206 chip	510-3602-689
C 216	3.9 pF ±5% NPO 1206 chip	510-3602-399
C 217	.1 µF ±10% X7R 1210	510-3607-104
C 218	.001 µF ±5% NPO 1206 chip	510-3602-102
C 219	.1 µF ±10% X7R 1210	510-3606-104
C 220	.001 µF ±5% NPO 1206 chip	510-3602-102
C 221	.1 µF ±10% X7R 1210	510-3606-104
C 222	120 pF ±5% NPO 1206 chip	510-3602-121
C 231	100 pF ±5% NPO 1206 chip	510-3602-101
C 232	4.7 µF 16V tantalum SMD	510-2625-479
C 233	.01 µF ±10% X7R chip	510-3606-103
C 234	.01 µF ±10% X7R chip	510-3606-103
C 235	220 pF ±5% NPO 1206 chip	510-3602-221
C 236	220 pF ±5% NPO 1206 chip	510-3602-221
C 237	5.6 pF ±5% NPO 1206	510-3602-569
C 238	390 pF ±5% NPO 1206	510-3602-391
C 240	4.7 µF 16V tantalum SMD	510-2625-479
C 251	.01 µF ±10% X7R 1206 chip	510-3606-103
C 252	.001 µF ±5% NPO 1206 chip	510-3602-102
C 253	.01 µF ±10% X7R 1206 chip	510-3606-103
C 254	100 pF ±5% NPO 1206 chip	510-3602-101
C 255	.1 µF ±10% X7R 1210	510-3607-104
C 256	.1 µF ±10% X7R 1210	510-3607-104
C 257	.1 µF ±10% X7R 1210	510-3607-104
C 258	27 pF ±5% NPO 1206 chip	510-3602-270
C 259	27 pF ±5% NPO 1206 chip	510-3602-270
C 260	27 pF ±5% NPO 1206 chip	510-3602-270
C 261	3.3 pF ±5% NPO 1206 chip	510-3602-339
C 262	27 pF ±5% NPO 1206 chip	510-3602-270
C 263	5.6 pF ±5% NPO 1206 chip	510-3602-569
C 264	27 pF ±5% NPO 1206 chip	510-3602-270
C 266	4.7 µF 16V tantalum SMD	510-2625-479
C 267	39 pF ±5% NPO 1206 chip	510-3602-390
C 268	1.5 pF ±5% NPO 1206 chip	510-3602-159
C 269	27 pF ±5% NPO 1206 chip	510-3602-270
C 270	39 pF ±5% NPO 1206 chip	510-3602-390
C 272	27 pF ±5% NPO 1206 chip	510-3602-270
C 273	27 pF ±5% NPO 1206 chip	510-3602-270
C 274	27 pF ±5% NPO 1206 chip	510-3602-270

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
C 275	2.4 pF ±5% NPO 1206 chip	510-3602-249
C 276	6.8 pF ±5% NPO 1206 chip	510-3602-689
C 277	4.3 pF ±5% NPO 1206 chip	510-3602-439
C 278	27 pF ±5% NPO 1206 chip	510-3602-270
C 279	4.7 µF 16V tantalum SMD	510-2625-479
C 280	12 pF ±5% NPO 1206 chip	510-3602-120
C 281	4.7 µF 16V tantalum SMD	510-2625-479
C 282	27 pF ±5% NPO 1206 chip	510-3602-270
C 284	1.5 pF ±5% NPO 1206 chip	510-3602-159
C 285	.001 µF ±5% NPO 1206 chip	510-3602-102
C 286	.001 µF ±5% NPO 1206 chip	510-3602-102
C 287	1.5 µF 25V tantalum SMD	510-2627-159
C 288	10 pF ±5% NPO 1206 chip	510-3602-100
C 289	4.7 µF 16V tantalum SMD	510-2625-479
C 290	.001 µF ±5% NPO 1206 chip	510-3602-102
C 291	.001 µF ±5% NPO 1206 chip	510-3602-102
C 292	1.5 µF 25V tantalum SMD	510-2627-159
C 293	39 pF ±5% NPO 1206 chip	510-3602-390
C 294	4.7 µF 16V tantalum SMD	510-2625-479
C 295	.001 µF ±5% NPO 1206 chip	510-3602-102
C 296	.001 µF ±5% NPO 1206 chip	510-3602-102
C 297	1.5 µF 25V tantalum SMD	510-2627-159
C 298	4.7 µF 16V tantalum SMD	510-2625-479
C 299	4.7 µF 16V tantalum SMD	510-2625-479
C 300	.001 µF ±5% NPO 1206 chip	510-3602-102
C 301	39 pF ±5% NPO 1206 chip	510-3602-390
C 302	27 pF ±5% NPO 1206 chip	510-3602-270
C 303	.1 µF ±10% X7R 1206	510-3606-104
C 304	39 pF ±5% NPO 1206 chip	510-3602-390
C 307	100 pF ±5% NPO 1206	510-3602-101
C 308	4.7 µF 16V tantalum SMD	510-2625-479
C 309	1 pF ±5% NPO 1206 chip	510-3602-109
C 310	27 pF ±5% NPO 1206 chip	510-3602-270
C 311	.001 µF ±5% NPO 1206 chip	510-3602-102
C 312	.001 µF ±5% NPO 1206 chip	510-3602-102
C 315	.001 µF ±5% NPO 1206 chip	510-3602-102
C 316	.01 µF ±10% X7R 1206	510-3606-103
C 317	.001 µF ±5% NPO 1206 chip	510-3602-102
C 318	.001 µF ±10% X7R 1206	510-3606-102
C 319	.001 µF ±5% NPO 1206 chip	510-3602-102
C 320	.001 µF ±5% NPO 1206 chip	510-3602-102
C 321	.001 µF ±5% NPO 1206 chip	510-3602-102
C 323	.001 µF ±5% NPO 1206 chip	510-3602-102
C 325	100 pF ±5% NPO 1206 chip	510-3602-101
C 326	3 pF ±5% NPO 1206 chip	510-3602-309
C 328	820 pF ±5% NPO 1206 chip	510-3602-821
C 330	27 pF ±5% NPO 1206 chip	510-3602-270
C 331	27 pF ±5% NPO 1206 chip	510-3602-270
C 332	27 pF ±5% NPO 1206 chip	510-3602-270
C 333	27 pF ±5% NPO 1206 chip	510-3602-270
C 334	27 pF ±5% NPO 1206 chip	510-3602-270
C 335	27 pF ±5% NPO 1206 chip	510-3602-270
C 336	4.7 µF 16V tantalum SMD	510-2625-479
C 337	56 pF ±5% NPO 1206 chip	510-3602-560
C 338	.01 µF ±10% X7R 1206	510-3606-103
C 356	2 pF ±5% NPO 1206 chip	510-3602-209
C 357	1.5 pF ±5% NPO 1206 chip	510-3602-159
C 358	3.9 pF ±5% NPO 1206 chip	510-3602-399
C 359	2.4 pF ±5% NPO 1206 chip	510-3602-249
C 362	4.7 µF 16V tantalum SMD	510-2625-479
C 363	.001 µF ±5% NPO 1206 chip	510-3602-102
C 364	1.5 µF 25V tantalum SMD	510-2627-159
C 365	4.7 µF 16V tantalum SMD	510-2625-479
C 366	.001 µF ±5% NPO 1206 chip	510-3602-102
C 367	27 pF ±5% NPO 1206 chip	510-3602-270
C 373	1.5-15 pF ceramic SMD	512-1602-001
C 374	4.7 pF ±5% NPO 1206 chip	510-3602-479
C 375	1.5-15 pF ceramic SMD	512-1602-001
C 376	4.7 pF ±5% NPO 1206 chip	510-3602-479
CH200	3-cavity helical front end	015-0901-038
CH201	3-cavity helical front end	015-0901-038
CH202	2-cavity helical front end	015-0901-028
CH203	1-cavity helical front end	015-0901-010
CR201	Hot carrier diode SOT-23	523-1504-016
CR002	Switching diode SOT-23	523-1504-002
CR203	Switching diode SOT-23	523-1504-002
CR204	Si 9.1V zener SOT-23	523-2016-919
EP200	Crystal pin cer insulator mini	010-0345-280
EP201	Ferrite bead SMD 1206	517-2503-002
EP202	Ferrite bead SMD 1206	517-2503-010
EP203	Ferrite bead SMD 1206	517-2503-001
EP204	Ferrite bead SMD 1206	517-2503-010
EP205	Ferrite bead SMD 1206	517-2503-001
EP206	Ferrite bead SMD 1206	517-2503-002
HW200	10-32 hex set screw NPB	575-9059-032
HW201	10-32 hex set screw NPB	575-9059-024
HW202	Tension lock nut CPS	560-1810-022
HW203	6-32 panhead Torx ZPS	575-0006-008
HW204	4-40 panhead slot nylon	575-4504-008
HW205	Polarizing key box cnt	515-7109-010

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
J 201	20-pin right angle header	515-9031-375
L 201	Helical coil	016-2186-201
L 202	2.25T helical coil	016-2186-205
L 203	Helical coil	016-2186-201
L 204	Helical coil	016-2186-201
L 205	2.25T helical coil	016-2186-205
L 206	Helical coil	016-2186-201
L 207	0.9 µH variable inductor 7mm	542-1012-008
L 209	0.9 µH variable inductor 7mm	542-1012-008
L 210	1.5T coil 22 AWG	542-0010-015
L 211	0.9 µH variable inductor 7mm	542-1012-008
L 212	1.5T coil 22 AWG	542-0010-015
L 213	.82 µH inductor SMD	542-9001-828
L 214	.1 µH inductor SMD	542-9001-108
L 215	.1 µH inductor SMD	542-9001-108
L 216	.1 µH inductor SMD	542-9001-108
L 218	.1 µH inductor SMD	542-9001-108
L 219	.018 µH inductor SMD	542-9001-187
L 220	2 3/8 turn helical coil	016-2186-254
L 221	3T 22 AWG 0.05 ID SMD air	542-0015-003
L 222	2T 22 AWG 0.05 ID SMD air	542-0015-002
L 223	Helical coil	016-2186-201
L 224	Helical coil	016-2186-201
L 225	0.9 µH variable inductor 7mm	542-1012-008
L 226	3T 22 AWG 0.05 ID SMD air	542-0015-003
L 227	3T 22 AWG 0.05 ID SMD air	542-0015-003
L 228	3T 22 AWG 0.05 ID SMD air	542-0015-003
L 229	.82 µH inductor SMD	542-9001-828
MP200	Helical coil form	013-1627-100
MP201	Helical coil form	013-1627-110
MP203	Damped washer 0.125	018-1132-152
MP204	Bottom shield	017-2210-101
PC200	PC board	035-2008-200
Q 201	NPN UHF low noise SOT-23	576-0003-636
Q 202	Si NPN RF amp SOT-23	576-0003-602
Q 205	Si NPN amp	576-0003-658
Q 208	NPN UHF low noise SOT-23	576-0003-636
Q 209	NPN UHF low noise SOT-23	576-0003-636
Q 210	Si NPN amp SOT-23	576-0003-658
Q 211	Si NPN amp SOT-23	576-0003-658
Q 214	NPN UHF low noise SOT-23	576-0003-636
Q 215	NPN UHF low noise SOT-23	576-0003-636
Q 216	NPN .2-2 GHz SO-8 amp	576-0003-604
Q 217	NPN 750 mW UHF/800 MHz	576-0004-098
Q 218	Si PNP low noise SOT-23	576-0003-657
R 201	10k ohm ±5% 1206 SMD	569-0115-103
R 203	62 ohm ±5% 1206 SMD	569-0115-620
R 204	10k ohm ±5% 1206 SMD	569-0115-103
R 208	1.8k ohm ±5% 1206 SMD	569-0115-182
R 209	680 ohm ±5% 1206 SMD	569-0115-681
R 211	51 ohm ±5% 1206 SMD	569-0115-510
R 212	100k ohm ±5% 1206 SMD	569-0115-104
R 213	5.1k ohm ±5% 1206 SMD	569-0115-512
R 214	51k ohm ±5% 1206 SMD	569-0115-513
R 215	1.8k ohm ±5% 1206 SMD	569-0115-182
R 227	10k ohm ±5% 1206 SMD	569-0115-103
R 228	1k ohm ±5% 1206 SMD	569-0115-102
R 229	10 ohm ±5% 1206 SMD	569-0115-100
R 230	270 ohm ±5% 1206 SMD	569-0115-271
R 231	10k ohm ±5% 1206 SMD	569-0115-103
R 232	10k ohm ±5% 1206 SMD	569-0115-103
R 247	2.2k ohm ±5% 1206 SMD	569-0115-222
R 248	2.7k ohm ±5% 1206 SMD	569-0115-272
R 249	3.3k ohm ±5% 1206 SMD	569-0115-332
R 250	270 ohm ±5% 1206 SMD	569-0115-271
R 251	3.3k ohm ±5% 1206 SMD	569-0115-332
R 252	330k ohm ±5% 1206 SMD	569-0115-334
R 253	6.8k ohm ±5% 1206 SMD	569-0115-682
R 254	330k ohm ±5% 1206 SMD	569-0115-334
R 255	27k ohm ±5% 1206 SMD	569-0115-273
R 256	20k ohm ±5% 1206 SMD	569-0115-203
R 257	470 ohm ±5% 1206 SMD	569-0115-471
R 258	150 ohm ±5% 1206 SMD	569-0115-151
R 259	10k ohm ±5% 1206 SMD	569-0115-103
R 260	Zero ohm ±10% 1206 SMD	569-0115-001
R 261	5k ohm single turn trimmer	562-0112-502
R 262	7.5k ohm ±5% 1206 SMD	569-0115-752
R 263	120k ohm ±5% 1206 SMD	569-0115-124
R 264	5k ohm single turn trimmer	562-0112-502
R 265	1.8k ohm ±5% 1206 SMD	569-0115-182
R 266	470 ohm ±5% 1206 SMD	569-0115-471
R 267	294 ohm ±1% 1206 SMD	569-0111-246
R 268	1k ohm ±1% 1206 SMD	569-0111-301
R 269	1k ohm ±5% 1206 SMD	569-0115-102
R 270	1k ohm ±5% 1206 SMD	569-0115-102
R 271	910 ohm ±5% 1206 SMD	569-0115-911
R 272	240 ohm ±5% 1206 SMD	569-0115-241
R 273	100 ohm ±5% 1206 SMD	569-0115-101
R 274	10 ohm ±5% 1206 SMD	569-0115-100

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
R 275	6.8k ohm ±5% 1206 SMD	569-0115-682
R 276	47k ohm ±5% 1206 SMD	569-0115-473
R 277	150 ohm ±5% 1206 SMD	569-0115-151
R 278	1.6k ohm ±5% 1206 SMD	569-0115-162
R 279	1.6k ohm ±5% 1206 SMD	569-0115-162
R 280	100k ohm ±5% 1206 SMD	569-0115-104
R 282	5k ohm single turn trimmer	562-0112-502
R 283	150 ohm ±5% 1206 SMD	569-0115-151
R 290	1.5k ohm ±5% 1206 SMD	569-0115-152
R 291	1.3k ohm ±5% 1206 SMD	569-0115-132
R 292	75 ohm ±5% 1206 SMD	569-0115-750
R 293	51 ohm ±5% 1206 SMD	569-0115-510
R 294	10 ohm ±5% 1206 SMD	569-0115-100
R 295	470 ohm ±5% 1206 SMD	569-0115-471
R 296	1.8k ohm ±5% 1206 SMD	569-0115-182
R 297	100 ohm ±5% 1206 SMD	569-0115-101
R 299	36 ohm ±5% 1206 SMD	569-0115-360
R 300	36 ohm ±5% 1206 SMD	569-0115-360
R 301	220 ohm ±5% 1206 SMD	569-0115-221
R 302	220 ohm ±5% 1206 SMD	569-0115-221
R 303	43 ohm ±5% 1206 SMD	569-0115-430
R 304	240 ohm ±5% 1206 SMD	569-0115-241
R 306	51 ohm ±5% 1206 SMD	569-0115-510
R 308	22 ohm ±5% 1206 SMD	569-0115-220
R 309	12.1k ohm ±1% 1206 SMD	569-0111-409
R 310	4.99k ohm ±1% 1206 SMD	569-0111-368
R 311	4.3k ohm ±5% 1206 SMD	569-0115-432
R 312	100 ohm ±5% 1206 SMD	569-0115-101
R 313	220 ohm ±5% 1206 SMD	569-0115-221
R 314	220 ohm ±5% 1206 SMD	569-0115-221
R 315	270 ohm ±5% 1206 SMD	569-0115-271
R 319	10k ohm ±5% 1206 SMD	569-0115-103
R 320	10k ohm ±5% 1206 SMD	569-0115-103
R 322	560 ohm ±5% 1206 SMD	569-0115-561
R 323	1k ohm ±5% 1206 SMD	569-0115-102
RT202	1k ohm ±5% thermistor chip	569-3013-002
TP001	Red vertical tip jack 0.08	105-2202-211
TP003	Red vertical tip jack 0.08	105-2202-211
TP004	Red vertical tip jack 0.08	105-2202-211
TP005	Red vertical tip jack 0.08	105-2202-211
TP006	Red vertical tip jack 0.08	105-2202-211
U 201	Mixer LRMS-2H	544-0007-013
U 202	FM IF MC3371D SO-16	544-2002-031
U 203	Dual op amp SOIC MC33178	544-2019-018
U 204	Op amp SO-8 MC33172D	544-2019-017
U 206	+12V regulator 78L12 SO-8	544-2603-032
U 207	+12V regulator 78L12 SO-8	544-2603-032
U 208	+5V regulator 78L05 SO-8	544-2603-039
U 209	Synthesizer MC145190F SOIC	544-3954-026
U 210	+12V regulator 78L12 SO-8	544-2603-032
Y 201	17.5 MHz crystal 1 PPM	518-7117-500
Z 201	52.95 MHz 4-pole 15 kHz BW	532-0009-009
Z 203	52.95 MHz 4-pole 15 kHz BW	532-0009-009
Z 205	450 kHz cer filter 15 kHz BW	532-2006-032
Z 213	455 kHz var inductor w/cap	542-1012-010
	TRANSMIT VCO 800 MHz PART NO. 023-2008-850	
C 802	1.5 pF 150V chip	510-3656-159
C 803	1 pF 150V chip	510-3656-109
C 804	2.4 pF ±0.1 pF 150V chip	510-3356-249
C 805	.1 µF ±10% X7R chip	510-3606-104
C 806	1 µF 16V tantalum SMD	510-2625-109
C 807	27 pF ±5% NPO 0805 chip	510-3601-270
C 808	27 pF ±5% NPO 0805 chip	510-3601-270
C 809	15 µF 20V tantalum SMD	510-2626-150
C 810	27 pF ±5% NPO 0805 chip	510-3601-270
C 811	27 pF ±5% NPO 0805 chip	510-3601-270
C 812	3.9 pF 150V chip	510-3656-399
C 813	5.6 pF 150V chip	510-3656-569
CR801	Varactor SOT-23 105G	523-1504-015
CR802	Varactor SOT-23 hyper	523-5004-002
L 803	.039 µH inductor SMD	542-9001-397
L 804	.039 µH inductor SMD	542-9001-397
L 805	.039 µH inductor SMD	542-9001-397
PC800	PC board	035-2008-800
Q 801	Si NPN gen purp switch/amp	576-0001-300
Q 802	NPN low noise SOT-23	576-0003-636
R 801	10 ohm ±5% 0805 chip	569-0105-100
R 802	3.6k ohm ±5% 0805 chip	569-0105-362
R 803	100 ohm ±5% 0805 chip	569-0105-101
R 804	12k ohm ±5% 0805 chip	569-0105-123
R 805	5.1k ohm ±5% 0805 chip	569-0105-512

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
R 806	6.2k ohm ±5% 0805 chip	569-0105-622
R 807	240 ohm ±5% 0805 chip	569-0105-241
R 814	10k ohm ±5% 1206 SMD	569-0115-103
	EXCITER PART NO. 023-2008-400	
A 007	800 MHz VCO	023-2008-850
C 409	.01 µF ±10% X7R chip	510-3606-103
C 410	.01 µF ±10% X7R chip	510-3606-103
C 416	.1 µF ±10% X7R 1210	510-3607-104
C 417	.01 µF ±10% X7R 1206 chip	510-3606-103
C 418	.001 µF ±5% NPO 1206 chip	510-3602-102
C 419	.01 µF ±10% X7R chip	510-3606-103
C 420	5.6 pF ±5% NPO 1206 chip	510-3602-569
C 421	4.7 µF 16V tantalum SMD	510-2625-479
C 422	.1 µF ±10% X7R 1210	510-3607-104
C 423	100 pF ±5% NPO 1206 chip	510-3602-101
C 424	.1 µF ±10% X7R 1210	510-3607-104
C 425	.1 µF ±10% X7R 1210	510-3607-104
C 426	4.7 µF 16V tantalum SMD	510-2625-479
C 428	4.7 µF 16V tantalum SMD	510-2625-479
C 429	27 pF ±5% NPO 1206 chip	510-3602-270
C 430	27 pF ±5% NPO 1206 chip	510-3602-270
C 431	27 pF ±5% NPO 1206 chip	510-3602-270
C 432	27 pF ±5% NPO 1206 chip	510-3602-270
C 433	2 pF ±5% NPO 1206 chip	510-3602-209
C 434	27 pF ±5% NPO 1206 chip	510-3602-270
C 441	1 pF ±5% NPO 1206 chip	510-3602-109
C 442	27 pF ±5% NPO 1206 chip	510-3602-270
C 443	27 pF ±5% NPO 1206 chip	510-3602-270
C 444	27 pF ±5% NPO 1206 chip	510-3602-270
C 445	27 pF ±5% NPO 1206 chip	510-3602-270
C 446	39 pF ±5% NPO 1206 chip	510-3602-390
C 447	1 µF 16V tantalum SMD	510-2625-109
C 448	27 pF ±5% NPO 1206 chip	510-3602-270
C 449	5.6 pF ±5% NPO 1206 chip	510-3602-569
C 450	39 pF ±5% NPO 1206 chip	510-3602-390
C 451	5.6 pF ±5% NPO 1206 chip	510-3602-569
C 453	820 pF ±5% NPO 1206 chip	510-3602-821
C 454	27 pF ±5% NPO 1206 chip	510-3602-270
C 455	.001 µF ±5% NPO 1206 chip	510-3602-102
C 457	39 pF ±5% NPO 1206 chip	510-3602-390
C 458	15 pF ±5% NPO 1206 chip	510-3602-150
C 459	15 pF ±5% NPO 1206 chip	510-3602-150
C 460	39 pF ±5% NPO 1206 chip	510-3602-390
C 461	15 pF ±5% NPO 1206 chip	510-3602-150
C 462	.001 µF ±5% NPO 1206 chip	510-3602-102
C 463	15 µF 20V tantalum SMD	510-2633-150
C 464	.01 µF ±10% X7R chip	510-3606-103
C 465	27 pF ±5% NPO 1206 chip	510-3602-270
C 466	.001 µF ±5% NPO 1206 chip	510-3602-102
C 467	1.5 µF 25V tantalum SMD	510-2627-159
C 469	4.7 µF 16V tantalum SMD	510-2625-479
C 470	.001 µF ±5% NPO 1206 chip	510-3602-102
C 471	.001 µF ±5% NPO 1206 chip	510-3602-102
C 472	1.5 µF 25V tantalum SMD	510-2627-159
C 474	4.7 µF 16V tantalum SMD	510-2625-479
C 475	.001 µF ±5% NPO 1206 chip	510-3602-102
C 476	4.7 µF 16V tantalum SMD	510-2625-479
C 479	27 pF ±5% NPO 1206 chip	510-3602-270
C 480	39 pF ±5% NPO 1206 chip	510-3602-390
C 481	1 µF 16V tantalum SMD	510-2625-109
C 482	27 pF ±5% NPO 1206 chip	510-3602-270
C 483	27 pF ±5% NPO 1206 chip	510-3602-270
C 484	27 pF ±5% NPO 1206 chip	510-3602-270
C 485	27 pF ±5% NPO 1206 chip	510-3602-270
C 496	15 µF 20V tantalum SMD	510-2633-150
C 497	100 pF ±5% NPO 1206 chip	510-3602-101
C 498	2.7 pF ±5% NPO 1206 chip	510-3602-279
C 499	27 pF ±5% NPO 1206 chip	510-3602-270
CH400	Single helical cavity front end	015-0901-010
CR401	Si 9.1V zener SOT-23	523-2016-919
EP400	Helical core form 1.25	013-1627-104
HW400	10-32 hex set screw NPB	575-9059-024
HW401	Tension lock nut CPS	560-1810-022
HW402	6-32 pan torx ZPS	575-0006-008
HW403	4-40 panhead slot nylon screw	575-4504-008
HW404	Polarized key box connector	515-7109-010
J 401	20-pin right angle header	515-9031-375
J 402	Right angle PC JCM-B	131-3701-301
L 402	.1 µH inductor SMD	542-9001-108
L 403	.018 µH inductor SMD	542-9001-187
L 404	2.125T helical coil	016-2186-207
L 406	.039 µH inductor SMD	542-9001-397
MP402	Damped washer 0.125	018-1132-152

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
PC401	PC board	035-2008-400
Q 403	Si NPN amp	576-0003-658
Q 404	Si NPN amp	576-0003-658
Q 405	Si PNP switching	576-0003-612
Q 406	Si NPN low noise SOT-23	576-0003-636
Q 407	Si NPN low noise SOT-23	576-0003-636
Q 410	Si NPN low noise SOT-23	576-0003-636
Q 411	Si NPN low noise SOT-23	576-0003-636
Q 412	Si NPN low noise SOT-23	576-0003-636
Q 413	NPN 750 mW UHF/800 MHz	576-0004-098
R 404	100 ohm ±5% SMD 1206	569-0115-101
R 405	1k ohm ±5% SMD 1206	569-0115-102
R 414	12.1k ohm ±1% SMD 1206	569-0111-409
R 415	4.99k ohm ±1% SMD 1206	569-0111-368
R 416	270 ohm ±5% SMD 1206	569-0115-271
R 417	10k ohm ±5% SMD 1206	569-0115-103
R 419	12.1k ohm ±1% SMD 1206	569-0111-409
R 424	10k ohm ±5% SMD 1206	569-0115-103
R 425	50k ohm single turn trimmer	562-0112-503
R 426	Zero ohm ±5% SMD 1206	569-0115-001
R 427	62k ohm ±5% SMD 1206	569-0115-623
R 428	10 ohm ±5% SMD 1206	569-0115-100
R 429	4.99k ohm ±1% SMD 1206	569-0111-368
R 430	2.7k ohm ±5% SMD 1206	569-0115-272
R 431	3.3k ohm ±5% SMD 1206	569-0115-332
R 432	3.3k ohm ±5% SMD 1206	569-0115-332
R 433	270 ohm ±5% SMD 1206	569-0115-271
R 434	294 ohm ±1% SMD 1206	569-0111-246
R 435	1k ohm ±1% SMD 1206	569-0111-301
R 436	100 ohm ±5% SMD 1206	569-0115-101
R 437	100 ohm ±5% SMD 1206	569-0115-101
R 438	10k ohm ±5% SMD 1206	569-0115-103
R 439	1k ohm ±5% SMD 1206	569-0115-102
R 440	1k ohm ±5% SMD 1206	569-0115-102
R 441	47k ohm ±5% SMD 1206	569-0115-473
R 443	36 ohm ±5% SMD 1206	569-0115-360
R 444	10k ohm ±5% SMD 1206	569-0115-103
R 445	100k ohm ±5% SMD 1206	569-0115-104
R 446	50k ohm single turn trimmer	562-0112-503
R 447	1k ohm ±5% SMD 1206	569-0115-102
R 448	10k ohm ±5% SMD 1206	569-0115-103
R 449	10k ohm ±5% SMD 1206	569-0115-103
R 450	10 ohm ±5% SMD 1206	569-0115-100
R 451	6.8k ohm ±5% SMD 1206	569-0115-682
R 452	100 ohm ±5% SMD 1206	569-0115-101
R 453	1.6k ohm ±5% SMD 1206	569-0115-162
R 454	1.6k ohm ±5% SMD 1206	569-0115-162
R 455	150 ohm ±5% SMD 1206	569-0115-151
R 456	470 ohm ±5% SMD 1206	569-0115-471
R 457	36 ohm ±5% SMD 1206	569-0115-360
R 458	47 ohm ±5% SMD 1206	569-0115-470
R 460	10 ohm ±5% SMD 1206	569-0115-100
R 462	10 ohm ±5% SMD 1206	569-0115-100
R 463	100 ohm ±5% SMD 1206	569-0115-101
R 464	5.6k ohm ±5% SMD 1206	569-0115-562
R 465	1.2k ohm ±5% SMD 1206	569-0115-122
R 466	1.6k ohm ±5% SMD 1206	569-0115-162
R 467	1.6k ohm ±5% SMD 1206	569-0115-162
R 468	150 ohm ±5% SMD 1206	569-0115-151
R 469	3.9k ohm ±5% SMD 1206	569-0115-392
R 470	1k ohm ±5% SMD 1206	569-0115-102
R 471	47 ohm ±5% SMD 1206	569-0115-470
R 472	150 ohm ±5% SMD 1206	569-0115-151
R 473	100 ohm ±5% SMD 1206	569-0115-101
R 474	1k ohm ±5% SMD 1206	569-0115-102
R 476	470 ohm ±5% SMD 1206	569-0115-471
R 477	100 ohm ±5% SMD 1206	569-0115-101
R 478	220 ohm ±5% SMD 1206	569-0115-221
R 479	220 ohm ±5% SMD 1206	569-0115-221
R 480	7.5k ohm ±5% SMD 1206	569-0115-752
R 481	1.3k ohm ±5% SMD 1206	569-0115-132
R 482	Zero ohm ±5% SMD 1206	569-0115-001
R 486	12.1k ohm ±1% SMD 1206	569-0111-409
R 487	4.99k ohm ±1% SMD 1206	569-0111-368
R 488	10k ohm ±5% SMD 1206	569-0115-103
U 402	Dual op amp SO-8 2904	544-2019-004
U 403	Synthesizer SOIC MC145190	544-3954-026
U 404	Dual op amp SO-8	544-2019-004
U 405	+5V regulator 78L05 SO-8	544-2603-039
U 406	+12V regulator 78L12 SO-8	544-2603-032
U 407	Dual op amp SO-8	544-2019-004
Y 401	17.5 MHz, 1 PPM TCXO	518-7117-500

75 WATT POWER AMPLIFIER
PART NO. 023-2008-540

C 501	27 pF ±5% NPO 1206 chip	510-3602-270
C 502	1 µF 35V tantalum SMD	510-2628-109
C 503	.1 µF 35V tantalum SMD	510-2628-108

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
C 504	.018 µF ±10% X&R 0805 chip	510-3605-183
C 505	1 µF 35V tantalum SMD	510-2628-109
C 506	.018 µF ±10% X&R 0805 chip	510-3605-183
C 507	56 pF ±10% high Q SMD	510-3653-560
C 508	56 pF ±10% high Q SMD	510-3653-560
C 509	27 pF ±5% NPO 1206 chip	510-3602-270
C 510	1 µF 35V tantalum SMD	510-2628-109
C 511	56 pF ±10% high Q SMD	510-3663-560
C 512	.1 µF 35V tantalum SMD	510-2628-108
C 513	1 µF 35V tantalum SMD	510-2628-109
C 514	.018 µF ±10% X7R chip	510-3605-183
C 515	56 pF ±10% high Q SMD	510-3663-560
C 516	1 µF 35V tantalum SMD	510-2628-109
C 517	.018 µF ±10% X7R chip	510-3605-183
C 518	56 pF ±10% high Q SMD	510-3663-560
C 519	10 pF ±5% NPO 1206 chip	510-3602-100
C 520	.001 µF ±5% NPO 1206 chip	510-3602-102
C 521	.001 µF ±5% NPO 1206 chip	510-3602-102
C 522	1.5 pF high Q cube	510-3663-159
C 527	56 pF ±10% high Q SMD	510-3663-560
C 528	.018 µF ±10% X7R chip	510-3605-183
C 529	.01 µF ±10% X7R chip	510-3606-103
C 530	.001 µF ±5% NPO 1206 chip	510-3602-102
C 531	6.8 µF 35V tantalum SMD	510-2635-689
C 532	27 pF ±10% high Q SMD	510-3663-270
C 533	56 pF ±10% high Q SMD	510-3663-560
C 534	6.8 µF 35V tantalum SMD	510-2635-689
C 535	.018 µF ±10% X7R chip	510-3605-183
C 536	3.9 pF ±10% high Q SMD	510-3663-399
C 538	15 pF ±10% high Q SMD	510-3663-150
C 540	5.1 pF ±10% high Q SMD	510-3663-519
C 542	56 pF ±10% high Q SMD	510-3663-560
C 543	27 pF ±10% high Q SMD	510-3663-270
C 544	.018 µF ±10% X7R chip	510-3605-183
C 545	6.8 µF 35V tantalum SMD	510-2635-689
C 546	.001 µF ±5% NPO 1206 chip	510-3602-102
C 547	56 pF ±10% high Q SMD	510-3663-560
C 548	.018 µF ±10% X7R chip	510-3605-183
C 549	6.8 µF 35V tantalum SMD	510-2635-689
C 550	56 pF ±10% high Q SMD	510-3663-560
C 551	3.9 pF ±10% high Q SMD	510-3663-399
C 553	56 pF ±10% high Q SMD	510-3663-560
C 554	5.1 pF ±10% high Q SMD	510-3663-519
C 556	56 pF ±10% high Q SMD	510-3663-560
C 557	27 pF ±10% high Q SMD	510-3663-270
C 558	.018 µF ±10% X7R chip	510-3605-183
C 559	6.8 µF 35V tantalum SMD	510-2635-689
C 560	.001 µF ±5% NPO 1206 chip	510-3602-102
C 561	56 pF ±10% high Q SMD	510-3663-560
C 562	.018 µF ±10% X7R chip	510-3605-183
C 563	6.8 µF 35V tantalum SMD	510-2635-689
C 564	56 pF ±10% high Q SMD	510-3663-560
C 565	3.9 pF ±10% high Q SMD	510-3663-399
C 567	56 pF ±10% high Q SMD	510-3663-560
C 568	1.5 pF ±10% high Q SMD	510-3663-159
C 569	39 pF ±5% NPO 1206 chip	510-3602-390
C 570	.018 µF ±10% X7R chip	510-3605-183
C 571	.018 µF ±10% X7R chip	510-3605-183
C 572	39 pF ±5% NPO 1206 chip	510-3602-390
C 573	.018 µF ±10% X7R chip	510-3605-183
C 574	.018 µF ±10% X7R chip	510-3605-183
C 575	56 pF ±10% high Q SMD	510-3663-560
C 576	1 µF 35V tantalum SMD	510-2628-109
C 577	4.7 µF 16V tantalum SMD	510-2625-479
C 578	.018 µF ±10% X7R chip	510-3605-183
C 579	.001 µF ±5% NPO 1206 chip	510-3602-102
C 580	4.7 µF 16V tantalum SMD	510-2625-479
C 581	.018 µF ±10% X7R chip	510-3605-183
C 582	1 µF 35V tantalum SMD	510-2628-109
C 583	39 pF ±5% NPO 1206 chip	510-3602-390
C 584	.001 µF ±5% NPO 1206 chip	510-3602-102
C 585	.018 µF ±10% X7R chip	510-3605-183
C 588	1.5 pF ±10% high Q SMD	510-3663-159
C 589	1.5 pF ±10% high Q SMD	510-3663-159
C 594	.001 µF ±5% NPO 1206 chip	510-3602-102
C 595	.018 µF ±10% X7R chip	510-3605-183
C 596	1 µF 35V tantalum SMD	510-2628-109
C 597	.1 µF 35V tantalum SMD	510-2628-108
C 598	.018 µF ±10% X7R chip	510-3605-183
CR501	Dual Schottky diode SOT-143	523-1504-033
CR502	Dual Schottky diode SOT-143	523-1504-033
CR503	Dual Schottky diode SOT-143	523-1504-033
CR504	4.7V zener SOT-23	523-2016-479
CR505	3.3V zener ±5% 3W SMT	523-2026-339
CR506	3.3V zener ±5% 3W SMT	523-2026-339
EP501	Ferrite bead SMD 1233	517-2503-010
EP502	Ferrite bead SMD 1233	517-2503-010
EP503	Ferrite bead SMD 1233	517-2503-010
EP504	Ferrite bead SMD 1233	517-2503-010
EP505	Ferrite bead SMD 1233	517-2503-010
EP506	Ferrite bead SMD 1233	517-2503-010
EP507	Ferrite bead SMD 1233	517-2503-010

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
EP508	Ferrite bead SMD 1233	517-2503-010
EP510	Ferrite bead SMD 1233	517-2503-010
EP511	Ferrite bead SMD 1233	517-2503-010
EP512	Ferrite bead SMD 1233	517-2503-010
EP513	Ferrite bead SMD 1233	517-2503-010
EP514	Ferrite bead SMD 1233	517-2503-010
EP515	Ferrite bead SMD 1233	517-2503-010
EP516	Ferrite bead SMD 1233	517-2503-010
EP517	Ferrite bead SMD 1233	517-2503-010
EP518	Ferrite bead SMD 1233	517-2503-010
EP520	Ferrite bead SMD 1233	517-2503-010
EP521	Ferrite bead SMD 1233	517-2503-010
L 502	.01 µH inductor SMD	542-9001-107
L 503	.01 µH inductor SMD	542-9001-107
PC009	PC board	035-2008-540
R 501	68 ohm ±5% 1206 SMD	569-0115-680
R 502	75 ohm ±5% 1206 SMD	569-0115-750
R 503	68 ohm ±5% 1206 SMD	569-0115-680
R 504	110 ohm ±5% 1206 SMD	569-0115-111
R 505	1k ohm ±5% 1206 SMD	569-0115-102
R 506	200 ohm ±5% 1206 SMD	569-0115-201
R 507	200 ohm ±5% 1206 SMD	569-0115-201
R 510	100 ohm ±5% 1206 SMD	569-0115-101
R 511	200 ohm ±5% 1206 SMD	569-0115-201
R 512	100 ohm ±5% 1206 SMD	569-0115-101
R 513	1k ohm ±1% 1206 SMD	569-0111-301
R 514	1k ohm ±1% 1206 SMD	569-0111-301
R 515	3.4k ohm ±1% 1206 SMD	569-0111-352
R 516	200 ohm ±5% 1206 SMD	569-0115-201
R 517	100 ohm ±5% 1206 SMD	569-0115-101
R 518	100 ohm ±5% 1206 SMD	569-0115-101
R 519	1k ohm ±1% 1206 SMD	569-0111-301
R 520	1k ohm ±1% 1206 SMD	569-0111-301
R 521	3.4k ohm ±1% 1206 SMD	569-0111-352
R 522	240 ohm ±5% 1206 SMD	569-0115-241
R 523	56 ohm ±5% 1206 SMD	569-0115-560
R 524	75 ohm ±5% 1206 SMD	569-0115-750
R 525	100k ohm ±1% 1206 SMD	569-0111-501
R 526	301k ohm ±1% 1206 SMD	569-0111-547
R 527	470 ohm ±5% 1206 SMD	569-0115-471
R 528	75 ohm ±5% 1206 SMD	569-0115-750
U 501	6W power module 800 MHz	544-4001-047
U 502	Dual op amp 532 SO-8	544-2019-004
U 503	Temp sensor LM35 SO-8	544-2032-003
U 504	+5V regulator 78L05 SO-8	544-2603-039

175 WATT POWER AMPLIFIER
PART NO. 023-2008-520

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
C 522	1 µF 35V tantalum SMD	510-2628-109
C 523	.018 µF ±10% X7R chip	510-3605-183
C 524	.1 µF 35V tantalum SMD	510-2628-108
C 525	1 µF 35V tantalum SMD	510-2628-109
C 526	.018 µF ±10% X7R chip	510-3605-183
C 527	1 µF 35V tantalum SMD	510-2628-109
C 528	56 pF ±10% high Q cube	510-3663-560
C 529	56 pF ±10% high Q cube	510-3663-560
C 530	56 pF ±10% high Q cube	510-3663-560
C 531	.1 µF 35V tantalum SMD	510-2628-108
C 532	1 µF 35V tantalum SMD	510-2628-109
C 533	.018 µF ±10% X7R chip	510-3605-183
C 534	56 pF ±10% high Q cube	510-3663-560
C 535	1 µF 35V tantalum SMD	510-2628-109
C 536	.018 µF ±10% X7R chip	510-3605-183
C 537	56 pF ±10% high Q cube	510-3663-560
C 538	.1 µF 35V tantalum SMD	510-2628-108
C 539	1 µF 35V tantalum SMD	510-2628-109
C 540	.018 µF ±10% X7R chip	510-3605-183
C 541	4.7 pF ±10% high Q cube	510-3663-479
C 543	56 pF ±10% high Q cube	510-3663-560
C 544	56 pF ±10% high Q cube	510-3663-560
C 545	.018 µF ±10% X7R chip	510-3605-183
C 546	.001 µF ±5% NPO 1206 chip	510-3602-102
C 547	6.8 µF 35V tantalum SMD	510-2635-689
C 548	56 pF ±10% high Q cube	510-3663-560
C 549	6.8 µF 35V tantalum SMD	510-2635-689
C 550	.018 µF ±10% X7R chip	510-3605-183
C 551	5.1 pF 500V mica SMD	510-0620-519
C 552	56 pF ±10% high Q cube	510-3663-560
C 553	56 pF ±10% high Q cube	510-3663-560
C 554	1 µF 35V tantalum SMD	510-2628-109
C 555	4.7 µF 16V tantalum SMD	510-2625-479
C 556	4.7 µF 16V tantalum SMD	510-2625-479
C 557	.018 µF ±10% X7R chip	510-3605-183
C 558	.001 µF ±5% NPO 1206 chip	510-3602-102
C 559	.018 µF ±10% X7R chip	510-3605-183
C 560	1 µF 16V tantalum SMD	510-2625-109
C 561	39 pF ±5% NPO 1206 chip	510-3602-390
C 562	.001 µF ±5% NPO 1206 chip	510-3602-102
C 563	.018 µF ±10% X7R chip	510-3605-183
C 565	10 pF ±5% NPO 1206 chip	510-3602-100
C 566	.001 µF ±5% NPO 1206 chip	510-3602-102
C 567	.001 µF ±5% NPO 1206 chip	510-3602-102
C 568	5.1 pF 500V mica SMD	510-0620-519
C 701	4.7 pF ±10% high Q cube	510-3663-479

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
C 703	3.9 pF 500V mica SMD	510-0620-399
C 704	56 pF ±10% high Q cube	510-3663-560
C 705	56 pF ±10% high Q cube	510-3663-560
C 706	6.8 µF 35V tantalum SMD	510-2635-689
C 707	.018 µF ±10% X7R chip	510-3605-183
C 708	56 pF ±10% high Q cube	510-3663-560
C 709	56 pF ±10% high Q cube	510-3663-560
C 710	.001 µF ±5% NPO 1206 chip	510-3602-102
C 711	6.8 µF 35V tantalum SMD	510-2635-689
C 712	.018 µF ±10% X7R chip	510-3605-183
C 713	4.7 pF ±10% high Q cube	510-3663-479
C 715	3.9 pF 500V mica SMD	510-0620-399
C 716	56 pF ±10% high Q cube	510-3663-560
C 717	56 pF ±10% high Q cube	510-3663-560
C 718	6.8 µF 35V tantalum SMD	510-2635-689
C 719	.018 µF ±10% X7R chip	510-3605-183
C 720	56 pF ±10% high Q cube	510-3663-560
C 721	56 pF ±10% high Q cube	510-3663-560
C 722	.001 µF ±5% NPO 1206 chip	510-3602-102
C 723	6.8 µF 35V tantalum SMD	510-2635-689
C 724	.018 µF ±10% X7R chip	510-3605-183
C 725	39 pF ±5% NPO 1206 chip	510-3602-390
C 726	.018 µF ±10% X7R chip	510-3605-183
C 727	.018 µF ±10% X7R chip	510-3605-183
C 728	39 pF ±5% NPO 1206 chip	510-3602-390
C 729	.018 µF ±10% X7R chip	510-3605-183
C 730	.018 µF ±10% X7R chip	510-3605-183
C 731	4.7 pF ±10% high Q cube	510-3663-479
C 733	3.9 pF 500V mica SMD	510-0620-399
C 734	56 pF ±10% high Q cube	510-3663-560
C 735	56 pF ±10% high Q cube	510-3663-560
C 736	6.8 µF 35V tantalum SMD	510-2635-689
C 737	.018 µF ±10% X7R chip	510-3605-183
C 738	56 pF ±10% high Q cube	510-3663-560
C 739	56 pF ±10% high Q cube	510-3663-560
C 740	.001 µF ±5% NPO 1206 chip	510-3602-102
C 741	6.8 µF 35V tantalum SMD	510-2635-689
C 742	.018 µF ±10% X7R chip	510-3605-183
C 743	4.7 pF ±10% high Q cube	510-3663-479
C 745	3.9 pF 500V mica SMD	510-0620-399
C 746	56 pF ±10% high Q cube	510-3663-560
C 747	56 pF ±10% high Q cube	510-3663-560
C 748	6.8 µF 35V tantalum SMD	510-2635-689
C 749	.018 µF ±10% X7R chip	510-3605-183
C 750	56 pF ±10% high Q cube	510-3663-560
C 751	56 pF ±10% high Q cube	510-3663-560
C 752	.001 µF ±5% NPO 1206 chip	510-3602-102
C 753	6.8 µF 35V tantalum SMD	510-2635-689
C 754	.018 µF ±10% X7R chip	510-3605-183
C 755	39 pF ±5% NPO 1206 chip	510-3602-390
C 756	.018 µF ±10% X7R chip	510-3605-183
C 757	.018 µF ±10% X7R chip	510-3605-183
C 758	39 pF ±5% NPO 1206 chip	510-3602-390
C 759	.018 µF ±10% X7R chip	510-3605-183
C 760	.018 µF ±10% X7R chip	510-3605-183
C 761	1.5 pF ±10% high Q cube	510-3663-159
C 762	1.5 pF ±10% high Q cube	510-3663-159
C 763	3.9 pF 500V mica SMD	510-0620-399
C 764	3.9 pF 500V mica SMD	510-0620-399
C 766	1.5 pF ±10% high Q cube	510-3663-159
C 767	3.9 pF 500V mica SMD	510-0620-399
C 768	3.9 pF 500V mica SMD	510-0620-399
C 771	56 pF ±10% high Q cube	510-3663-560
C 772	56 pF ±10% high Q cube	510-3663-560
C 773	56 pF ±10% high Q cube	510-3663-560
C 774	56 pF ±10% high Q cube	510-3663-560
CR501	Dual Schottky SOT-143	523-1504-033
CR701	Dual Schottky SOT-143	523-1504-033
CR702	Dual Schottky SOT-143	523-1504-033
CR703	Dual Schottky SOT-143	523-1504-033
CR704	Dual Schottky SOT-143	523-1504-033
EP502	Ferrite bead SMD 1233	517-2503-010
EP503	Ferrite bead SMD 1233	517-2503-010
EP504	Ferrite bead SMD 1233	517-2503-010
EP505	Ferrite bead SMD 1233	517-2503-010
EP506	Ferrite bead SMD 1233	517-2503-010
EP507	Ferrite bead SMD 1233	517-2503-010
EP508	Ferrite bead SMD 1233	517-2503-010
EP509	Ferrite bead SMD 1233	517-2503-010
EP510	Ferrite bead SMD 1233	517-2503-010
EP511	Ferrite bead SMD 1233	517-2503-010
EP513	Ferrite bead SMD 1233	517-2503-010
EP701	Ferrite bead SMD 1233	517-2503-010
EP702	Ferrite bead SMD 1233	517-2503-010
EP703	Ferrite bead SMD 1233	517-2503-010
EP704	Ferrite bead SMD 1233	517-2503-010
EP705	Ferrite bead SMD 1233	517-2503-010
EP706	Ferrite bead SMD 1233	517-2503-010
EP707	Ferrite bead SMD 1233	517-2503-010
EP708	Ferrite bead SMD 1233	517-2503-010
EP709	Ferrite bead SMD 1233	517-2503-010
EP710	Ferrite bead SMD 1233	517-2503-010

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
EP711	Ferrite bead SMD 1233	517-2503-010
EP712	Ferrite bead SMD 1233	517-2503-010
EP713	Ferrite bead SMD 1233	517-2503-010
EP714	Ferrite bead SMD 1233	517-2503-010
EP715	Ferrite bead SMD 1233	517-2503-010
EP716	Ferrite bead SMD 1233	517-2503-010
L 503	.01 µH SMD	542-9001-107
L 504	.01 µH SMD	542-9001-107
PC501	PC board	035-2008-520
R 510	240 ohm ±5% 1206 SMD	569-0115-241
R 511	56 ohm ±5% 1206 SMD	569-0115-560
R 512	75 ohm ±5% 1206 SMD	569-0115-750
R 513	100k ohm ±1% 1206 SMD	569-0111-501
R 514	301k ohm ±1% 1206 SMD	569-0111-547
R 515	470 ohm ±5% 1206 SMD	569-0115-471
R 517	110 ohm ±5% 1206 SMD	569-0115-111
R 519	1k ohm ±5% 1206 SMD	569-0115-102
R 520	470 ohm ±5% 1206 SMD	569-0115-471
R 521	2.7k ohm ±5% 1206 SMD	569-0115-272
R 528	2.7k ohm ±5% 1206 SMD	569-0115-272
R 529	2.7k ohm ±5% 1206 SMD	569-0115-272
R 531	Zero ohm ±5% 1206 SMD	569-0115-001
R 532	Zero ohm ±5% 1206 SMD	569-0115-001
R 704	100 ohm ±5% 1206 SMD	569-0115-101
R 705	200 ohm ±5% 1206 SMD	569-0115-201
R 706	100 ohm ±5% 1206 SMD	569-0115-101
R 707	1k ohm ±1% 1206 SMD	569-0111-301
R 708	1k ohm ±1% 1206 SMD	569-0111-301
R 709	3.4k ohm ±1% 1206 SMD	569-0111-352
R 710	100 ohm ±5% 1206 SMD	569-0115-101
R 711	200 ohm ±5% 1206 SMD	569-0115-201
R 712	100 ohm ±5% 1206 SMD	569-0115-101
R 713	1k ohm ±1% 1206 SMD	569-0111-301
R 714	1k ohm ±1% 1206 SMD	569-0111-301
R 715	3.4k ohm ±1% 1206 SMD	569-0111-352
R 718	100 ohm ±5% 1206 SMD	569-0115-101
R 719	200 ohm ±5% 1206 SMD	569-0115-201
R 720	100 ohm ±5% 1206 SMD	569-0115-101
R 721	1k ohm ±1% 1206 SMD	569-0115-301
R 722	1k ohm ±1% 1206 SMD	569-0115-301
R 723	3.4k ohm ±1% 1206 SMD	569-0115-352
R 724	100 ohm ±5% 1206 SMD	569-0115-101
R 725	200 ohm ±5% 1206 SMD	569-0115-201
R 726	100 ohm ±5% 1206 SMD	569-0115-201

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
R 727	1k ohm ±1% 1206 SMD	569-0111-301
R 728	1k ohm ±1% 1206 SMD	569-0111-301
R 729	3.4k ohm ±1% 1206 SMD	569-0111-352
U 502	Dual op amp 532 SO-8	544-2019-004
U 503	Temp sensor LM35 SO-8	544-2032-003
U 504	+5V regulator 78L05 SO-8	544-2603-039

LOW-PASS FILTER
PART NO. 023-2008-630

A 625	Low pass filter assembly	023-2008-625
MP600	Low pass filter mounting plate	017-2210-098

FORWARD/REVERSE
POWER DETECTOR
PART NO. 023-2008-680

C 653	27 pF ±5% NPO 0805 chip	510-3601-270
C 654	12 pF ±5% NPO 1206 chip	510-3602-120
C 658	27 pF ±5% NPO 0805 chip	510-3601-270
C 659	.001 µF ±10% X7R 0805 chip	510-3605-102
C 660	2.2 µF 20V tantalum SMD	510-2626-229
C 661	4.7 µF 10V tantalum SMD	510-2624-479
C 662	4.7 µF 10V tantalum SMD	510-2624-479
C 663	.001 µF ±10% X7R 0805 chip	510-3605-102
C 664	27 pF ±5% NPO 0805 chip	510-3601-270
C 665	27 pF ±5% NPO 0805 chip	510-3601-270
C 667	27 pF ±5% NPO 0805 chip	510-3601-270
C 668	27 pF ±5% NPO 0805 chip	510-3601-270
C 669	27 pF ±5% NPO 0805 chip	510-3601-270
C 670	27 pF ±5% NPO 0805 chip	510-3601-270
C 671	27 pF ±5% NPO 0805 chip	510-3601-270
C 672	27 pF ±5% NPO 0805 chip	510-3601-270
C 673	.001 µF ±10% X7R 0805 chip	510-3605-102
C 674	27 pF ±5% NPO 0805 chip	510-3601-270
C 675	27 pF ±5% NPO 0805 chip	510-3601-270
C 676	27 pF ±5% NPO 0805 chip	510-3601-270
C 677	27 pF ±5% NPO 0805 chip	510-3601-270
C 678	27 pF ±5% NPO 0805 chip	510-3601-270
C 679	.001 µF ±10% X7R 0805 chip	510-3605-102
C 681	.001 µF ±10% X7R 0805 chip	510-3605-102
C 682	.001 µF ±10% X7R 0805 chip	510-3605-102
C 683	4.7 µF 10V tantalum SMD	510-2624-479
C 684	.001 µF ±10% X7R 0805 chip	510-3605-102

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
CR651	Dual Schottky SOT-143	523-1504-033
CR652	Dual Schottky SOT-143	523-1504-033
L 652	12.5 nH inductor SMD	542-0030-004
L 653	.039 µH inductor SMD	542-9001-397
L 655	12.5 nH inductor SMD	542-0030-004
L 656	.039 µH inductor SMD	542-9001-397
L 657	12.5 nH inductor SMD	542-0030-004
MP651	PC board shield	017-2210-086
MP652	PC board shield	017-2210-086
MP653	Power detector mount	017-2210-096
R 653	160 ohm ±5% 1206 SMD	569-0115-161
R 655	Zero ohm ±5% 1206 SMD	569-0115-001
R 656	20k ohm ±1% 1206 SMD	569-0111-430
R 658	10k ohm ±1% 1206 SMD	569-0111-401
R 659	10k ohm ±1% 1206 SMD	569-0111-401
R 660	10k ohm ±1% 1206 SMD	569-0111-401
R 662	10k ohm ±1% 1206 SMD	569-0111-401
R 663	5k ohm top adjust SMD pot	562-0135-502
R 664	160 ohm ±5% 1206 SMD	569-0115-161
R 665	10k ohm ±1% 1206 SMD	569-0111-401
R 666	10k ohm ±1% 1206 SMD	569-0111-401
R 667	470 ohm ±5% 1206 SMD	569-0115-471
R 668	Zero ohm ±5% 1206 SMD	569-0115-001
R 670	160 ohm ±5% 1206 SMD	569-0115-161
R 672	Zero ohm ±5% 1206 SMD	569-0115-001
R 673	20k ohm ±1% 1206 SMD	569-0111-430
R 675	10k ohm ±1% 1206 SMD	569-0111-401
R 676	10k ohm ±1% 1206 SMD	569-0111-401
R 677	10k ohm ±1% 1206 SMD	569-0111-401
R 678	10k ohm ±1% 1206 SMD	569-0111-401
R 680	5k ohm top adjust SMD pot	562-0135-502
R 681	150 ohm ±5% 0805 SMD	569-0105-151
R 682	7.5k ohm ±5% 0805 SMD	569-0105-752
R 683	10k ohm ±5% 0805 SMD	569-0105-103
R 684	470 ohm ±5% 0805 SMD	569-0105-471
R 686	47 ohm ±5% 1206 SMD	569-0115-470
R 687	240 ohm ±5% 1206 SMD	569-0115-241
R 688	10k ohm ±1% 1206 SMD	569-0111-401
R 689	10k ohm ±5% 1206 SMD	569-0115-103
U 651	Dual op amp SO-8	544-2019-004
U 652	Dual op amp SO-8	544-2019-004
U 653	+5V regulator LM78L05 SO-8	544-2603-039

75W POWER AMPLIFIER MECHANICAL
PART NO. 023-2008-742

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
B 252	24V DC fan 3.14" sq x 1.26"	529-2002-027
EP200	6-14 ground lug	586-0007-070
HW251	6-32 panhead philips ZPS	575-1606-008
HW253	6-32 panhead philips ZPS	575-1606-012
HW254	1/8" cable clamp	572-0001-001
HW255	6-32 pan torx ZPS	575-0006-010
HW256	4-40 panhead philips ZPS	575-1604-010
HW257	6-32 panhead philips ZPS	575-1606-010
HW258	6-32 panhead philips ZPS	575-1606-016
HW259	6-19 panhead philips ZPS	575-5606-008
HW260	6-32 lockwasher int ZPS	596-1206-010
HW261	0.26 x 0.54 grafoil flgres	018-1007-030
HW262	0.42 x 0.995 grafoil mrf	018-1007-032
HW263	894.25 x 0.995 grafoil mrf	018-1007-034
HW264	0.385 x 0.88 grafoil flgres	018-1007-036
HW265	Grafoil 6W power module	018-1007-045
HW266	Grafoil circulator	018-1007-042
HW268	10-32 HHSL Sems ZPS	575-9810-012
HW269	0.062 x 0.85 x 5.65 poron stp	574-3002-110
MP254	M PA plate align dowel pin	013-1723-216
MP255	PA heat sink	014-0771-124
MP256	UHF PA shield	017-2210-121
MP257	PA shield, top	017-2210-022
MP258	PA shield, 1 fan, low power	017-2210-025
MP262	PA shield, high power LPF	017-2210-097
MP268	M PA stop	013-1723-222
MP270	PA shield	017-2210-095

175W POWER AMPLIFIER MECHANICAL
PART NO. 023-2008-734

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
B 252	24V DC fan 3.14" sq x 1.26"	529-2002-027
EP100	Balanced finger gasket	537-5001-006
EP200	6-14 ground lug	586-0007-070
HW251	3/16 #2 panhead sheet mtl	575-3602-006
HW253	6-32 panhead philips ZPS	575-1606-012
HW254	1/8" cable clamp	572-0001-001
HW255	6-32 pan torx ZPS	575-0006-010
HW256	4-40 panhead philips ZPS	575-1604-010

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
HW257	6-32 panhead philips ZPS	575-1606-010
HW258	6-32 panhead philips ZPS	575-1606-016
HW259	6-19 panhead philips ZPS	575-5606-008
HW260	6-32 lockwasher int ZPS	596-1206-010
HW261	0.26 x 0.54 grafoil flgres	018-1007-030
HW262	0.42 x 0.995 grafoil mrf	018-1007-032
HW264	0.385 x 0.88 grafoil flgres	018-1007-036
HW265	Grafoil MHW-820	018-1007-038
HW266	Grafoil circulator	018-1007-042
HW267	Grafoil MRT-898	018-1007-033
HW268	10-32 HHSL Sems ZPS	575-9810-012
HW269	0.062 x 0.85 x 5.65 poron stp	574-3002-110
HW270	8-32 panhead phil CPS screw	575-0608-008
MP240	Pa coax ground tab	017-2210-038
MP254	M PA plate align dowel pin	013-1723-216
MP255	PA heat sink	014-0771-124
MP256	High power PA shield, left	017-2210-026
MP257	PA shield, top	017-2210-022
MP258	High power PA shield, right	017-2210-023
MP261	1/4" hex brass M/F spacer	312-7483-024
MP262	PA shield, high power LPF	017-2210-097
MP265	High power RF PC bd shield	017-2210-034
MP266	High power RF PC bd shield	017-2210-035
MP268	M PA stop	013-1723-222
MP269	Pre-driver cover shield	017-2210-036
MP270	PA shield	017-2210-095

2000 SERIES REPEATER POWER SUPPLY
PART NO. 023-2000-800

A 801	Main board assembly	023-2000-810
A 803	AC filter board assembly	023-2000-820
B 800	24V DC fan 3.14” square	529-2002-012
HW800	Speed nut	537-0001-002
HW801	10-32 x 0.375 CPS nut	560-1110-012
HW802	6-32 x 0.094 nut	560-1106-010
HW803	4-40 machine panhead ZPS	575-1604-010
HW804	6-32 machine panhead ZPS	575-1606-010
HW805	6-32 machine panhead ZPS	575-1606-016
HW806	Washer	596-2406-012
HW808	#4 shakeproof washer	596-1104-008
HW809	6 x 0.018 lockwasher int.	596-1106-009
HW810	3/8” cable clamp	572-0001-005
HW811	#10 split lock washer	596-1310-010
HW812	Snap rivet 0.157 dia.	574-9015-052
HW813	Connector mounting	515-7141-215
J 800	2-pos lock receptacle #22 wire	515-9032-262
MP801	Main enclosure	017-2210-165
MP802	Top cover	017-2210-166
MP803	Handle	017-2139-202
MP804	Strain releif	016-2187-270
MP805	Fan finger guard	578-1000-001
MP806	Filter bracket cover	017-2210-168
NP800	Nameplate holder	015-0900-406
NP801	Nameplate label	559-5861-161

WIREHARNESS
PART NO. 023-2000-803

EP001	Power socket	515-9012-284
EP002	Signal socket	515-9012-291
MP001	15-pos plug	515-9012-272

800W POWER SUPPLY MAIN BOARD
PART NO. 023-2000-810

A 002	??	
A 802	Wireharness	023-2000-803
A 803	Thermal sensor board assem	023-2000-840
C 101	220 µF 25V aluminum radial	510-4225-221
C 102	.01 µF ±5% X7R 1206	510-3609-103
C 103	220 nF ±10% X7R 1210	510-3606-224
C 104	1 µF 35V tantalum SMD	510-2628-109
C 105	1 µF 35V tantalum SMD	510-2628-109
C 106	1500 µF 35Valuminum elect	510-4075-152
C 107	1500 µF 35Valuminum elect	510-4075-152
C 108	470 pF ±5% NPO 1206	510-3602-471
C 109	.1 µF ±10% X7R 1206	510-3609-104
C 110	330 µF 450V aluminum	510-4574-331
C 111	330 µF 450V aluminum	510-4574-331
C 113	.0047 µF ±10% X7R 1206	510-3609-472
C 114	.1 µF ±10% X7R 1206	510-3609-104
C 115	.1 µF ±10% X7R 1206	510-3609-104
C 116	.1 µF ±10% X7R 1206	510-3609-104
C 117	.47 µF 16V tantalum SMD	510-2625-478
C 118	270 pF ±5% NPO 1206	510-3602-271

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
C 119	1 µF 35V tantalum SMD	510-2628-109
C 120	270 pF ±5% NPO 1206	510-3602-271
C 121	.0027 µF ±5% X7R 1206	510-3609-272
C 122	470 pF ±5% NPO 1206	510-3602-471
C 123	1 µF 35V tantalum SMD	510-2628-109
C 124	.1 µF ±10% X7R 1206	510-3609-104
C 125	.0022 µF ±5% X7R 1206	510-3609-222
C 126	.1 µF ±5% X7R 1206	510-3609-104
C 127	.01 µF ±10% X7R 1206	510-3609-103
C 128	6.8 µF 35V tantalum SMD	510-2635-689
C 129	.1 µF ±10% X7R 1206	510-3609-104
C 131	.1 µF ±10% X7R 1206	510-3609-104
C 132	1 µF 35V tantalum SMD	510-2628-109
C 133	1 µF 35V tantalum SMD	510-2628-109
C 134	.1 µF ±5% X7R 1206	510-3609-104
C 135	.1 µF ±5% X7R 1206	510-3609-104
C 136	2.2 µF 16V tantalum SMD	510-2625-229
C 137	2.2 µF 16V tantalum SMD	510-2625-229
C 138	.001 µF ±5% NPO 1206	510-3602-102
C 139	6.8 µF 35V tantalum SMD	510-2635-689
C 140	6.8 µF 35V tantalum SMD	510-2635-689
C 141	.1 µF ±5% X7R 1206	510-3609-104
C 142	1 nF 600V AC double m	510-1023-102
C 143	2700 µF 35V aluminum	510-4075-272
C 144	2700 µF 35V aluminum	510-4075-272
C 145	2700 µF 35V aluminum	510-4075-272
C 146	.1 µF ±5% X7R 1206	510-3609-104
C 147	.1 µF ±5% X7R 1206	510-3609-104
C 148	.1 µF ±5% X7R 1206	510-3609-104
C 149	.1 µF ±5% X7R 1206	510-3609-104
C 150	.01 µF ±5% X7R 1206	510-3609-103
C 152	.1 µF ±5% X7R 1206	510-3609-104
C 153	1 µF 35V tantalum SMD	510-2628-109
C 154	.1 µF ±5% X7R chip	510-3609-104
C 156	.01 µF ±5% X7R 1206	510-3609-103
C 159	6.8 µF 35V tantalum SMD	510-2635-689
C 160	15 µF 20V tantalum SMD	510-2633-150
C 161	.01 µF ±5% X7R 1206	510-3609-103
C 162	.1 µF ±5% X7R 1206	510-3609-104
C 163	2700 µF 35V aluminum	510-4075-272
C 164	.001 µF ±5% NPO 1206	510-3602-102
C 165	1500 µF 35V aluminum	510-4075-152
C 166	1500 µF 35V aluminum	510-4075-152
C 167	.01 µF ±5% X7R 1206	510-3609-103
C 168	.01 µF ±5% X7R 1206	510-3609-103
C 169	1500 µF 35V aluminum	510-4075-152
C 170	.01 µF ±5% X7R 1206	510-3609-103
C 172	.01 µF ±5% X7R 1206	510-3609-103
C 173	.1 µF ±5% X7R 1206	510-3609-104
C 174	2200 pF ±5% NPO 1206	510-3602-222
C 175	.22 µF ±10% X7R 1210	510-3606-224
C 176	.001 µF ±5% NPO 1206	510-3602-102
C 178	1 µF 35V tantalum SMD	510-2628-109
C 180	6.8 µF 35V tantalum SMD	510-2635-689
C 181	.01 µF ±5% X7R 1206	510-3609-103
C 182	470 pF ±5% NPO 1206	510-3602-471
C 183	270 pF ±5% NPO 1206	510-3602-271
C 184	.1 µF ±5% X7R 1206	510-3609-104
C 185	.001 µF ±5% NPO 1206	510-3602-102
C 186	1500 µF 35V aluminum	510-4075-152
C 187	1500 µF 35V aluminum	510-4075-152
C 188	1500 µF 35V aluminum	510-4075-152
C 189	.01 µF ±5% X7R 1206	510-3609-103
C 190	.01 µF ±5% X7R 1206	510-3609-103
C 192	.1 µF ±5% X7R 1206	510-3609-104
C 193	2200 pF ±5% NPO 1206	510-3602-222
C 194	.22 µF ±10% X7R 1210	510-3606-224
C 195	.01 µF ±5% X7R 1206	510-3609-103
C 196	.001 µF ±5% NPO 1206	510-3602-102
C 197	2.2 µF 16V tantalum SMD	510-2625-229
C 198	1 µF 35V tantalum SMD	510-2628-109
C 199	6.8 µF 35V tantalum SMD	510-2635-689
C 200	6.8 µF 35V tantalum SMD	510-2635-689
C 201	.01 µF ±5% X7R 1206	510-3609-103
C 202	470 pF ±5% NPO 1206	510-3602-471
C 203	470 pF ±5% NPO 1206	510-3602-471
C 204	.047 µF ±5% X7R 1206	510-3609-473
C 205	1500 µF 35V aluminum	510-4075-152
C 207	2200 pF ±5% NPO 1206	510-3602-222
C 208	.1 µF ±5% X7R 1206	510-3609-104
C 209	1500 µF 35V aluminum	510-4075-152
C 210	2200 pF ±5% NPO 1206	510-3602-222
C 211	.01 µF ±5% X7R 1206	510-3609-103
C 212	.01 µF ±5% X7R 1206	510-3609-103
C 213	.1 µF ±5% X7R 1206	510-3609-104
C 214	.01 µF ±5% X7R 1206	510-3609-103
C 215	.1 µF ±5% X7R 1206	510-3609-104
C 216	.01 µF ±5% X7R 1206	510-3609-103
C 217	.1 µF ±5% X7R 1206	510-3609-104
C 218	.01 µF ±5% X7R 1206	510-3609-103
C 219	.1 µF ±5% X7R 1206	510-3609-104
C 220	.1 µF ±5% X7R 1206	510-3609-104
C 221	.01 µF ±5% X7R 1206	510-3609-103
C 222	.1 µF ±5% X7R 1206	510-3609-104

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
C 223	.1 µF ±5% X7R 1206	510-3609-104
C 224	.01 µF ±5% X7R 1206	510-3609-103
C 225	.01 µF ±5% X7R 1206	510-3609-103
C 227	.1 µF ±5% X7R 1206	510-3609-104
C 228	2.2 µF 16V tantalum SMD	510-2625-229
C 229	.1 µF ±5% X7R 1206	510-3609-104
C 230	1 µF 35V tantalum SMD	510-2628-109
C 232	6.8 µF 35V tantalum SMD	510-2635-689
C 233	.1 µF ±5% X7R 1206	510-3609-104
C 234	.001 µF ±5% NPO 1206	510-3602-102
C 235	.1 µF ±5% X7R 1206	510-3609-104
C 236	.1 µF ±5% X7R 1206	510-3609-104
CR101	Switching diode SOT-23	523-1504-002
CR102	Switching diode SOT-23	523-1504-002
CR103	3A ultra-fast diode	523-1507-004
CR104	18V zener ±5% SMD	523-2026-180
CR105	1A Schottky diode	523-0519-031
CR106	1A Schottky diode	523-0519-031
CR107	Switching diode SOT-23	523-1504-017
CR108	Switching diode SOT-23	523-1504-017
CR110	Switching diode SOT-23	523-1504-002
CR111	Switching diode SOT-23	523-1504-002
CR112	Switch diode SOT-23	523-1504-017
CR113	5.1V zener SOT-23	523-2016-519
CR114	1A Schottky diode	523-0519-031
CR115	1A Schottky diode	523-0519-031
CR116	1A Schottky diode	523-0519-031
CR117	18V zener SOT-23	523-2016-180
CR118	3A ultra-fast diode	523-1507-004
CR119	3A ultra-fast diode	523-1507-004
CR120	18V zener SOT-23	523-2016-180
CR121	Ultra-fast rectifier	523-0019-024
CR122	Switch diode SOT-23	523-1504-017
CR123	1A Schottky diode	523-0519-031
CR124	1A Schottky diode	523-0519-031
CR125	1A Schottky diode	523-0519-031
CR126	Schottkey diode 20A	523-0519-030
CR127	Switch diode SOT-23	523-1504-017
CR128	Ultra-fast rectifier	523-0019-024
CR129	25A 400V SCR TO-220	523-3021-001
CR130	1A Schottky diode	523-0519-031
CR131	1A Schottky diode	523-0519-031
CR132	Schottkey diode 20A	523-0519-030
CR133	Switch diode SOT-23	523-1504-017
CR134	1A Schottky diode	523-0519-031
CR135	25A 400V SCR TO-220	523-3021-001
CR136	3A ultra-fast diode	523-1507-004
CR137	Switching diode SOT-23	523-1504-002
CR138	Switching diode SOT-23	523-1504-002
CR139	Dual switching common cath	523-1504-022
CR140	4.7V zener SOT-23	523-2016-479
CR141	25A 400V SCR TO-220	523-3021-001
CR142	Switch diode SOT-23	523-1504-017
CR143	Switch diode SOT-23	523-1504-017
CR145	8A 600V ultrafast diode	523-0019-026
CR148	13V 1W zener SMT	523-2026-130
EP100	Ferrite bead	517-2002-008
EP101	0.25” spade lug	586-3502-021
EP103	0.25” spade lug	586-3502-021
EP104	0.25” spade lug	586-3502-021
EP105	0.25” spade lug	586-3502-021
EP106	0.25” spade lug	586-3502-021
EP110	0.25” spade lug	586-3502-021
EP111	0.25” spade lug	586-3502-021
EP112	0.25” spade lug	586-3502-021
F 102	10A 250V fastblow AGC fuse	534-0003-036
FH102	Fuse clip	534-1007-001
HW100	Cam5 x 3.795 sil-pad	018-1007-051
HW101	0.89 x 1.37 sil-pad	018-1007-052
HW102	1.06 x 4.73 sil-pad	018-1007-053
HW104	0.83 x 5 Teflon spacer	018-1007-056
HW105	0.83” Teflon spacer	018-1007-057
HW106	1.28” Teflon spacer	018-1007-058
HW107	4-40 3/8” hex socket CPS	575-9076-122
HW108	6-32 3/8” socket hoodcap	575-9076-112
HW109	6-32 machine panhead ZPS	575-1606-012
HW110	#4 x 0.046 shoulder washer	596-4504-008
HW111	#4 x 0.040 flat washer NPB	596-2404-008
HW112	#6 x 0.028 flat washer NPB	596-2406-010
HW113	#4 shakeproof washer	596-1104-008
HW114	#6 x 0.018 int lockwasher	596-1106-009
HW115	#4 spring washer	596-9604-009
HW120	TO-220 clamp	537-9055-051
J 101	2-pin friction header	515-9031-201
J 102	2-pin friction header	515-9031-201

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
L 101	15 µH 30A DC inductor	542-5010-005
L 102	20 µH 8A DC inductor	542-5010-006
L 103	7.5 µH 8A DC inductor	542-5010-008
L 104	10 µH 5A DC inductor	542-5010-007
L 105	100 µH 1A DC inductor	542-5010-012
L 107	300 µH 17A DC inductor	542-5010-015
MP100	5.7" heat sink	014-0771-130
MP101	2.9" heat sink	014-0771-131
MP102	5.7" heat sink	014-0771-133
MP105	TO-202 spacer	017-2210-162
PC001	PC board	035-2000-810
Q 101	30A 500V N-chnl pwr module	576-0006-354
Q 102	PNP switching	576-0003-612
Q 103	Si NPN amp/sw SOT-23	576-0003-600
Q 104	PNP high current SOT-223	576-0006-026
Q 105	PNP switching	576-0003-612
Q 106	Si NPN amp/sw SOT-23	576-0003-600
Q 107	PNP high current SOT-223	576-0006-026
Q 108	NPN high current SOT-223	576-0006-027
Q 110	Si NPN amp/sw SOT-23	576-0003-600
Q 111	Si NPN amp/sw SOT-23	576-0003-600
Q 112	Si NPN amp/sw SOT-23	576-0003-600
Q 114	PNP switching	576-0003-612
Q 115	PNP high current SOT-223	576-0006-026
Q 116	14A 500V N-MOSFET	576-0006-351
Q 117	PNP high current SOT-223	576-0006-026
Q 118	14A 500V N-MOSFET	576-0006-351
Q 120	Si NPN amp/sw SOT-23	576-0003-600
Q 121	PNP 6A SMD MJD42C	576-0002-603
Q 122	PNP high current SOT-223	576-0006-026
Q 123	N-Chnl E-MOSFET SOT-23	576-0006-110
Q 124	PNP high current SOT-223	576-0006-026
Q 125	20A 200V N-MOSFET	576-0006-352
Q 126	PNP switching	576-0003-612
Q 127	Si NPN amp/sw SOT-23	576-0003-600
Q 128	PNP switching	576-0003-612
Q 129	PNP high current SOT-223	576-0006-026
Q 130	N-Chnl E-MOSFET SOT-23	576-0006-110
Q 131	PNP high current SOT-223	576-0006-026
Q 132	20A 200V N-MOSFET	576-0006-352
Q 133	PNP switching	576-0003-612
Q 138	PNP switching	576-0003-612
R 101	330k ohm ±5% 1206 SMD	569-0115-334
R 102	330k ohm ±5% 1206 SMD	569-0115-334
R 103	240k ohm ±5% 1206 SMD	569-0115-244
R 104	100k ohm ±5% 1206 SMD	569-0115-104
R 105	330k ohm ±5% 1206 SMD	569-0115-334
R 106	330k ohm ±5% 1206 SMD	569-0115-334
R 107	330k ohm ±5% 1206 SMD	569-0115-334
R 108	20k ohm ±5% 2512 SMD	569-0175-203
R 109	20k ohm ±5% 2512 SMD	569-0175-203
R 110	20k ohm ±5% 2512 SMD	569-0175-203
R 111	220 ohm ±5% 1206 SMD	569-0115-221
R 112	10 ohm ±5% 1206 SMD	569-0115-100
R 113	0.03 ohm 55W lo ind wire	569-4151-307
R 114	0.03 ohm 55W lo ind wire	569-4151-307
R 115	4.7k ohm ±5% 1206 SMD	569-0115-472
R 116	36k ohm ±5% 1206 SMD	569-0115-363
R 117	330 ohm ±5% 1206 SMD	569-0115-331
R 118	18.2k ohm ±1% 1206 SMD	569-0111-426
R 119	24.3k ohm ±1% 1206 SMD	569-0111-438
R 120	20k ohm ±5% 2512 SMD	569-0175-203
R 121	100k ohm ±1% 1206 SMD	569-0111-501
R 122	100k ohm ±1% 1206 SMD	569-0111-501
R 123	100k ohm ±1% 1206 SMD	569-0111-501
R 124	100k ohm ±1% 1206 SMD	569-0111-501
R 125	13 ohm ±5% 1206 SMD	569-0115-130
R 126	10 ohm ±5% 1206 SMD	562-0115-100
R 127	1.27k ohm ±1% 1206 SMD	569-0111-311
R 128	51 ohm ±5% 2512 SMD	569-0175-510
R 129	36k ohm ±5% 1206 SMD	569-0115-363
R 130	100k ohm ±5% 1206 SMD	569-0115-104
R 131	36k ohm ±5% 1206 SMD	569-0115-363
R 132	10k ohm ±5% 1206 SMD	569-0115-103
R 133	100k ohm ±5% 1206 SMD	569-0115-104
R 134	20k ohm ±5% 1206 SMD	569-0115-203
R 135	13k ohm ±1% 1206 SMD	569-0111-412
R 136	100k ohm ±5% 1206 SMD	569-0115-104
R 137	1M ohm ±5% 1206 SMD	569-0115-105
R 138	2.26k ohm ±1% 1206 SMD	569-0111-335
R 139	2.26k ohm ±1% 1206 SMD	569-0111-335
R 140	15k ohm ±1% 1206 SMD	569-0111-418
R 141	10k ohm ±5% 1206 SMD	569-0115-103
R 142	560k ohm ±5% 1206 SMD	569-0115-564
R 143	3k ohm ±5% 1206 SMD	569-0115-302
R 144	25.5k ohm ±1% 1206 SMD	569-0111-440
R 146	100 ohm ±5% 1206 SMD	569-0115-101
R 148	4.7k ohm ±5% 1206 SMD	569-0115-472
R 149	1k ohm ±5% 1206 SMD	569-0115-102
R 150	2k ohm ±5% 1206 SMD	569-0115-202

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
R 151	20k ohm ±5% 2512 SMD	569-0175-203
R 152	4.7k ohm ±5% 1206 SMD	569-0115-472
R 153	100 ohm ±5% 1206 SMD	569-0115-101
R 154	10k ohm ±5% 1206 SMD	569-0115-103
R 155	36k ohm ±5% 1206 SMD	569-0115-363
R 156	1k ohm ±5% 1206 SMD	569-0115-102
R 157	20k ohm ±5% 1206 SMD	569-0115-203
R 158	15k ohm ±5% 1206 SMD	569-0115-153
R 159	20 ohm ±5% 1206 SMD	569-0115-200
R 160	470 ohm ±5% 1206 SMD	569-0115-471
R 161	20 ohm ±5% 1206 SMD	569-0115-200
R 162	Zero ohm ±5% 1206 SMD	569-0115-001
R 163	20 ohm ±5% 1206 SMD	569-0115-200
R 164	470 ohm ±5% 1206 SMD	569-0115-471
R 165	20 ohm ±5% 1206 SMD	569-0115-200
R 166	10 ohm ±5% 2512 SMD	569-0175-100
R 167	10 ohm ±5% 2512 SMD	569-0175-100
R 168	10 ohm ±5% 2512 SMD	569-0175-100
R 169	1k ohm ±5% 1206 SMD	569-0115-102
R 170	820 ohm ±5% 1206 SMD	569-0115-821
R 171	820 ohm ±5% 1206 SMD	569-0115-821
R 172	100k ohm ±5% 1206 SMD	569-0115-104
R 173	16.9k ohm ±1% 1206 SMD	569-0111-423
R 174	1k ohm trim pot	562-0110-102
R 175	1.8k ohm ±5% 1206 SMD	569-0115-182
R 176	100 ohm ±5% 1206 SMD	569-0115-101
R 178	2k ohm ±5% 1206 SMD	569-0115-202
R 179	4.7k ohm ±5% 1206 SMD	569-0115-472
R 180	7.5k ohm ±5% 1206 SMD	569-0115-752
R 181	1k ohm ±5% 1206 SMD	569-0115-102
R 182	75 ohm ±5% 1206 SMD	569-0115-750
R 183	95.3k ohm ±1% 1206 SMD	569-0111-495
R 184	357k ohm ±1% 1206 SMD	569-0111-554
R 185	1k ohm ±5% 1206 SMD	569-0115-102
R 186	10k ohm ±5% 1206 SMD	569-0115-103
R 187	95.3k ohm ±1% 1206 SMD	569-0111-495
R 188	10k ohm ±1% 1206 SMD	569-0111-401
R 189	6.81k ohm ±1% 1206 SMD	569-0111-381
R 190	1k ohm ±5% 1206 SMD	569-0115-102
R 191	3.3k ohm ±5% 1206 SMD	569-0115-332
R 192	8.2k ohm ±5% 1206 SMD	569-0115-822
R 193	8.2k ohm ±5% 1206 SMD	569-0115-822
R 194	8.2k ohm ±5% 1206 SMD	569-0115-822
R 195	8.2k ohm ±5% 1206 SMD	569-0115-822
R 196	8.2k ohm ±5% 1206 SMD	569-0115-822
R 197	10k ohm ±5% 1206 SMD	569-0115-103
R 198	18 ohm ±5% 1206 SMD	569-0115-180
R 199	18 ohm ±5% 1206 SMD	569-0115-180
R 200	18 ohm ±5% 1206 SMD	569-0115-180
R 201	180 ohm ±5% 1206 SMD	569-0115-181
R 202	20k ohm ±5% 1206 SMD	569-0115-203
R 203	2k ohm ±5% 1206 SMD	569-0115-202
R 204	2k ohm ±5% 2512 SMD	569-0175-202
R 205	10 ohm ±5% 1206 SMD	569-0115-100
R 206	10 ohm ±5% 1206 SMD	569-0115-100
R 207	180 ohm ±5% 1206 SMD	569-0115-181
R 208	51 ohm ±5% 1206 SMD	569-0115-510
R 209	820 ohm ±5% 1206 SMD	569-0115-821
R 210	820 ohm ±5% 1206 SMD	569-0115-821
R 211	12.4k ohm ±1% 1206 SMD	569-0111-410
R 212	2.26k ohm ±1% 1206 SMD	569-0111-335
R 213	200 ohm ±5% 1206 SMD	569-0115-201
R 214	1k ohm ±5% 1206 SMD	569-0115-102
R 215	6.2k ohm ±5% 1206 SMD	569-0115-622
R 216	1k ohm single turn trimmer	562-0112-102
R 217	1.2k ohm ±5% 1206 SMD	569-0115-122
R 218	4.7k ohm ±5% 1206 SMD	569-0115-472
R 219	470 ohm ±5% 1206 SMD	569-0115-471
R 220	2k ohm ±1% 1206 SMD	569-0111-330
R 221	36k ohm ±5% 1206 SMD	569-0115-363
R 222	Zero ohm ±5% 1206 SMD	569-0115-001
R 223	13k ohm ±5% 1206 SMD	569-0115-133
R 224	Zero ohm ±5% 1206 SMD	569-0115-001
R 225	68 ohm ±5% 1206 SMD	569-0115-680
R 226	24 ohm ±5% 1206 SMD	569-0115-240
R 227	180 ohm ±5% 1206 SMD	569-0115-181
R 228	2k ohm ±1% 1206 SMD	569-0111-330
R 229	820 ohm ±5% 1206 SMD	569-0115-821
R 230	100 ohm ±5% 1206 SMD	569-0115-101
R 231	51 ohm ±5% 2512 SMD	569-0175-510
R 232	820 ohm ±5% 1206 SMD	569-0115-821
R 233	3.3k ohm ±5% 1206 SMD	569-0115-332
R 234	1k ohm ±5% 1206 SMD	569-0115-102
R 235	18 ohm ±5% 1206 SMD	569-0115-180
R 236	18 ohm ±5% 1206 SMD	569-0115-180
R 237	18 ohm ±5% 1206 SMD	569-0115-180
R 238	180 ohm ±5% 1206 SMD	569-0115-181
R 240	2k ohm ±5% 1206 SMD	569-0115-202
R 241	2k ohm ±5% 2512 SMD	569-0175-202
R 242	10 ohm ±5% 1206 SMD	569-0115-100
R 243	10 ohm ±5% 1206 SMD	569-0115-100
R 244	180 ohm ±5% 1206 SMD	569-0115-181
R 245	51 ohm ±5% 1206 SMD	569-0115-510
R 246	200 ohm ±5% 1206 SMD	569-0115-201

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
R 247	36 ohm ±5% 1206 SMD	569-0115-360
R 249	3.4k ohm ±1% 1206 SMD	569-0111-352
R 250	2.49k ohm ±1% 1206 SMD	569-0111-339
R 251	200 ohm ±5% 1206 SMD	569-0115-201
R 252	1k ohm ±5% 1206 SMD	569-0115-102
R 253	4.7k ohm ±5% 1206 SMD	569-0115-472
R 254	1k ohm single turn trimmer	562-0112-102
R 255	4.3k ohm ±5% 1206 SMD	569-0115-432
R 256	2k ohm ±1% 1206 SMD	569-0111-330
R 257	10k ohm ±5% 1206 SMD	569-0115-103
R 258	36k ohm ±5% 1206 SMD	569-0115-363
R 259	13k ohm ±5% 1206 SMD	569-0115-133
R 260	68 ohm ±5% 1206 SMD	569-0115-680
R 261	24 ohm ±5% 1206 SMD	569-0115-240
R 262	29.4k ohm ±1% 1206 SMD	569-0111-446
R 263	2.49k ohm ±1% 1206 SMD	569-0111-339
R 264	2k ohm ±1% 1206 SMD	569-0111-330
R 265	3.3k ohm ±5% 1206 SMD	569-0115-332
R 266	1k ohm ±5% 1206 SMD	569-0115-102
R 267	430 ohm ±5% 1206 SMD	569-0115-431
R 268	4.7k ohm ±5% 1206 SMD	569-0115-472
R 269	360 ohm ±5% 1206 SMD	569-0115-361
R 270	33k ohm ±5% 1206 SMD	569-0115-333
R 271	3.3k ohm ±5% 1206 SMD	569-0115-332
R 272	51 ohm ±5% 2512 SMD	569-0175-510
R 273	1k ohm ±5% 1206 SMD	569-0115-102
R 275	20k ohm ±5% 1206 SMD	569-0115-203
R 276	10k ohm ±5% 1206 SMD	569-0115-103
R 277	10k ohm ±5% 1206 SMD	569-0115-103
R 278	10k ohm ±5% 1206 SMD	569-0115-103
R 279	10k ohm ±5% 1206 SMD	569-0115-103
R 280	75 ohm ±5% 1206 SMD	569-0115-750
R 281	470k ohm ±5% 1206 SMD	569-0115-471
R 284	3.4k ohm ±1% 1206 SMD	569-0111-352
R 285	2.49k ohm ±1% 1206 SMD	569-0111-339
R 286	1k ohm ±5% 1206 SMD	569-0115-102
R 287	200 ohm ±5% 1206 SMD	569-0115-201
R 302	20k ohm ±5% 1206 SMD	569-0115-203
R 303	200 ohm ±5% 1206 SMD	569-0115-201
R 306	20k ohm ±5% 1206 SMD	569-0115-203
R 307	Zero ohm ±5% 1206 SMD	569-0115-001
R 308	Zero ohm ±5% 1206 SMD	569-0115-001
R 309	Zero ohm ±5% 1206 SMD	569-0115-001
R 311	100k ohm ±1% 1206 SMD	569-0111-501
R 312	100k ohm ±1% 1206 SMD	569-0111-501
R 313	100k ohm ±1% 1206 SMD	569-0111-501
R 314	100k ohm ±1% 1206 SMD	569-0111-501
R 315	820 ohm ±5% 1206 SMD	569-0115-821

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
RT101	8A 2.5 ohm NTC thermistor	569-3014-001
RT102	8A 2.5 ohm NTC thermistor	569-3014-001
T 101	0.5 line freq. bias transformer	592-3041-006T
103	1:200 current transformer	592-3041-002
T 104	1:200 current transformer	592-3041-002
T 105	100:1 current transformer	592-3041-005
T 106	1:1 transformer	592-3041-003
T 107	4.5:1 switch mode transformer	592-3041-001
U 102	PFC/PWN combo SOIC	544-2002-035
U 104	Quad 2-in AND SOIC HC08	544-3766-008
U 105	5V regulator LM78L05ABD	544-2603-039
U 106	5V regulator LM78L05ABD	544-2603-039
U 107	Opto-isolator surface mt	544-9022-001
U 108	Opto-isolator	544-2010-005
U 109	Programmable TL431AID	544-2003-097
U 110	Quad op amp LMC660 SOIC	544-2020-020
U 111	Adj volt reg full temp LM317T	544-2003-094
U 112	PWM current mode ML4823	544-2002-034
U 113	PWM current mode ML4823	544-2002-034
U 114	5V 3A regulator power supply	544-2003-098
U 115	Programmable TL431AID	544-2003-097
U 116	Programmable TL431AID	544-2003-097
U 117	Programmable TL431AID	544-2003-097
U 118	Programmable TL431AID	544-2003-097
U 119	Opto-isolator SOIC-8	544-2010-006
U 120	Opto-isolator SOIC-8	544-2010-006
U 121	Programmable volt TL431AID	544-2010-006
U 122	Opto-isolator SOIC-8	544-2010-006

AC FILTER BOARD
PART NO. 023-2000-820

C 001	.22 µF 275V AC ±2%	510-1024-224
C 003	.0022 µF ±2% Y2	510-1022-222
C 004	.0022 µF ±2% Y2	510-1022-222
C 005	1 µF 275V X2 class capacitor	510-1024-105
CR001	600V 35A rectifier bridge	523-4004-025
EP006	1/2” tubing	042-0241-557
F 001	15A 250V ceramic body	534-0003-045
FH001	Fuse clip	534-1007-001

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
HW001	#10 shakeproof washer	596-1110-012
HW002	4-40 machine panhead ZPS	575-1604-016
HW003	9/16" ID rubber grommet	574-0002-004
HW004	10-32 machine panhead ZPS	575-1610-016
HW005	#4 whakeproof washer	596-1104-008
HW007	Heatsink Grafoil TO-15	018-1007-055
J 001	AC power cord connector	515-0028-008
L 001	1 µH 10A coil	542-5010-010
L 002	4.2 µH 10A coil	542-5010-009
MP001	Filter bracket	017-2210-167
PC001	PC board	035-2000-820
R 001	1M ohm ±5% 1/4W CF	569-0513-105
RV001	Metal oxide varistor	569-3503-001
RV002	Metal oxide varistor	569-3503-001
W 001	Wire 1 assembly	023-2000-825
W 002	Wire 2 assembly	023-2000-826
W 003	Wire 3 assembly	023-2000-827
W 004	Wire 4 assembly	023-2000-828
W 005	Wire 5 assembly	023-2000-829

BATTERY BACK-UP
PART NO. 023-2000-830

C 101	.01 µF ±10% X7R chip	510-3606-103
C 103	6.8 µF 35V tantalum SMD	510-2635-689
C 104	.1 µF ±5% X7R 1206	510-3609-104
C 105	1000 µF 50Valuminum elect	510-4076-102
C 106	.1 µF ±5% X7R 1206	510-3609-104
C 107	.1 µF ±5% X7R 1206	510-3609-104
C 109	.1 µF ±5% X7R 1206	510-3609-104
C 110	6.8 µF 35V tantalum SMD	510-2635-689
C 111	1000 µF 50Valuminum elect	510-4076-102
C 112	.1 µF ±5% X7R 1206	510-3609-104
C 113	1 µF 35V tantalum SMD	510-2628-109
C 114	.1 µF ±5% X7R 1206	510-3609-104
C 115	.1 µF ±5% X7R 1206	510-3609-104
C 118	1 µF ±10% 100V polyester	510-1031-105
C 119	220 µF 25V aluminum radial	510-4225-221
C 124	1 µF 35V tantalum SMD	510-2628-109
C 125	.1 µF ±5% X7R 1206	510-3609-104
C 126	.1 µF ±5% X7R 1206	510-3609-104
C 127	.1 µF ±5% X7R 1206	510-3606-104
C 128	.01 µF ±10% X7R 1206	510-3606-103
C 129	.1 µF ±10% X7R 1206	510-3606-104
C 130	.01 µF ±10% X7R 1206	510-3606-103
C 131	.1 µF ±10% X7R 1206	510-3606-104
C 132	.01 µF ±10% X7R 1206	510-3606-103
C 133	.1 µF ±10% X7R 1206	510-3606-104
C 134	.01 µF ±10% X7R 1206	510-3606-103
CR101	Red LED right angle PC mt	549-4001-035
CR102	3A ultra-fast diode	523-1507-004
CR103	12V zener diode	523-2016-120
CR104	18V ±5% zener SMT	523-2026-180
CR105	Red LED right angle PC mt	549-4001-035
CR109	8A 600V ultra-fast diode	523-0019-026
CR111	Green LED rt angle PC mt	549-4001-037
CR113	Switching diode SOT-23	523-1504-002
CR114	3A ultra-fast diode	523-1507-004
CR115	Switching diode SOT-23	523-1504-002
CR116	3A ultra-fast diode	523-1507-004
CR117	13V 1W zener SMT	523-2026-130
CR118	18V ±5% zener SMT	523-2026-180
EP100	Heat sink insulator TO-220	574-5005-060
EP101	Copper terminal lug	586-0007-072
EP102	Copper terminal lug	586-0007-072
EP103	Copper terminal lug	586-0007-071
F 101	4A resettable polyfuse	534-0020-001
HW100	4-40 machine panhead ZPS	575-1604-012
HW101	6-32 machine panhead ZPS	575-1606-008
HW102	4 x 0.04 flat washer	596-2404-008
HW103	6 x 0.018 int lockwasher	596-1106-009
HW104	#4 shakeproof washer	596-1104-008
HW105	10-32 machine panhead ZPS	575-1610-012
HW106	#10 shakeproof washer	596-1110-012
HW107	4 x 0.46 shoulder washer	596-4504-008
HW108	10-32 x 0.375 CPS	560-1110-012
J 100	2-pin lock receptacle	515-9032-232
K 101	Single pole 24V relay	567-0031-001
L 101	70 µH 3A Toroid inductor	542-5010-014

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
MP100	Bracket	017-2210-169
MP101	Terminal cover	032-0758-050
NP100	Max input 28.5V Bat/Backup	559-5861-166
PC001	PC board	035-2000-830
Q 101	PNP high current SOT-223	576-0006-026
Q 102	PNP high current SOT-223	576-0006-026
Q 103	N-channel E-MOSFET	576-0006-110
Q 104	PNP TO-220 ISO	576-0002-057
Q 105	PNP high current SOT-223	576-0006-026
R 101	4.7k ohm ±5% 1206 SMD	569-0115-472
R 102	330 ohm ±5% 1206 SMD	569-0115-331
R 103	2k ohm ±5% 1206 SMD	569-0115-202
R 104	2k ohm ±5% 1206 SMD	569-0115-202
R 105	2k ohm ±5% 1206 SMD	569-0115-202
R 106	2k ohm ±5% 2512 SMD	569-0175-202
R 107	1k ohm ±5% 1206 SMD	569-0115-102
R 108	2k ohm ±5% 1206 SMD	569-0115-202
R 109	2k ohm ±5% 1206 SMD	569-0115-202
R 110	2k ohm ±5% 1206 SMD	569-0115-202
R 111	51 ohm ±5% 1W 2512 SMD	569-0175-510
R 112	7.5k ohm ±1% 1206 SMD	569-0111-385
R 112	1k ohm ±1% 1206 SMD	569-0111-301
R 115	470 ohm ±5% 1W 2512 SMD	569-0175-471
R 116	47 ohm ±5% 1206 SMD	569-0115-470
R 117	3.3k ohm ±5% 1206 SMD	569-0115-332
R 118	10.5k ohm ±1% 1206 SMD	569-0111-403
R 119	1k ohm ±1% 1206 SMD	569-0111-301
R 120	1k ohm ±1% 1206 SMD	569-0111-301
R 121	62k ohm ±5% 1206 SMD	569-0115-623
R 122	4.7k ohm ±5% 1206 SMD	569-0115-472
R 123	10k ohm ±5% 1206 SMD	569-0115-103
R 124	10k ohm ±5% 1206 SMD	569-0115-103
R 125	1k ohm ±1% 1206 SMD	569-0111-301
R 126	42.2k ohm ±1% 1206 SMD	569-0111-461
R 127	82.5k ohm ±1% 1206 SMD	569-0111-489
R 128	10k ohm ±5% 1206 SMD	569-0115-103
R 129	20k ohm ±5% 1206 SMD	569-0115-203
R 130	33k ohm ±5% 1206 SMD	569-0115-333
R 136	3.3k ohm ±5% 2512 SMD	569-0175-332
R 137	3.3k ohm ±5% 2512 SMD	569-0175-332
R 138	240 ohm ±5% 2512 SMD	569-0115-241
R 139	3.3k ohm ±5% 2512 SMD	569-0175-332
R 140	1k ohm single turn trimmer	562-0112-102
R 141	Zero ohm ±5% 1206 SMD	569-0115-001
R 142	10k ohm ±5% 1206 SMD	569-0115-103
R 143	2k ohm ±5% 2512 SMD	569-0175-202
R 144	15k ohm ±5% 1206 SMD	569-0115-153
R 145	15k ohm ±5% 1206 SMD	569-0115-153
R 146	3.9k ohm ±5% 1206 SMD	569-0115-392
R 147	10k ohm ±5% 1206 SMD	569-0115-103
R 148	15k ohm ±5% 1206 SMD	569-0115-153
R 149	82k ohm ±5% 1206 SMD	569-0115-823
R 150	10k ohm ±5% 1206 SMD	569-0115-103
R 151	100 ohm ±5% 1206 SMD	569-0115-101
R 152	75 ohm ±5% 1206 SMD	569-0115-750
R 153	100k ohm ±5% 1206 SMD	569-0115-104
R 154	300k ohm ±5% 1206 SMD	569-0115-304
R 156	10k ohm ±5% 1206 SMD	569-0115-103
R 157	15k ohm ±1% 1206 SMD	569-0111-301
R 158	1k ohm ±1% 1206 SMD	569-0111-301
R 159	180k ohm ±5% 1206 SMD	569-0115-184
R 160	10k ohm ±5% 1206 SMD	569-0115-103
R 165	2k ohm ±5% 2512 SMD	569-0175-202
S 101	Toggle switch on/on rt angle	583-0006-014
U 101	Quad comparator 2901	544-2025-011
U 102	Programmable voltage reg	544-2003-097
U 103	Programmable voltage reg	544-2003-097
U 104	Dual op amp SO-8	544-2019-004
U 105	Dual op amp SO-8	544-2019-004
U 106	Temp sensor LM-35 SO-8	544-2032-003
U 107	Full temp adjustable LM317T	544-2003-094
W 101	Green wire assembly	023-2000-836
W 102	Red wire assembly	023-2000-837
W 103	Black wire assembly	023-2000-838
W 104	Orange wire assembly	023-2000-839

THERMAL SENSOR BOARD
PART NO. 023-2000-840

A 001	Thermal sensor board assem	023-2000-841
C 001	.1 µF 10% X7R chip	510-3606-104
J 001	48 mil edge clip, short	515-9034-004
J 002	48 mil edge clip, short	515-9034-004
J 003	48 mil edge clip, short	515-9034-004
PC001	Thermal sensor board	035-2000-840
U 001	Temp sensor LM-35 SO-8	544-2032-003

MAIN PROCESSOR CARD
PART NO. 023-2000-310

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
C 001	10 pF ±5% NPO 1206 chip	510-3602-100
C 002	20 pF ±5% NPO 1206 chip	510-3602-200
C 004	.01 µF ±10% X7R chip	510-3606-103
C 005	.01 µF ±10% X7R chip	510-3606-103
C 006	.01 µF ±10% X7R chip	510-3606-103
C 007	.01 µF ±10% X7R chip	510-3606-103
C 008	10 pF ±5% NPO 1206 chip	510-3602-100
C 009	.01 µF ±10% X7R chip	510-3606-103
C 010	.01 µF ±10% X7R chip	510-3606-103
C 011	.01 µF ±10% X7R chip	510-3606-103
C 012	.01 µF ±10% X7R chip	510-3606-103
C 013	20 pF ±5% NPO 1206 chip	510-3602-200
C 014	10 µF 16V tantalum SMD	510-2625-100
C 015	.01 µF ±10% X7R chip	510-3606-103
C 016	.01 µF ±10% X7R chip	510-3606-103
C 017	47 µF 25V electrolytic radial	510-4425-470
C 018	47 µF 25V electrolytic radial	510-4425-470
C 019	62 pF ±5% NPO 1206 chip	510-3602-620
C 020	.1 µF ±10% X7R chip	510-3606-104
C 021	.1 µF ±10% X7R chip	510-3606-104
C 022	.1 µF ±10% X7R chip	510-3606-104
C 023	.1 µF ±10% X7R chip	510-3606-104
C 024	10 µF 16V tantalum SMD	510-2625-100
C 025	10 µF 16V tantalum SMD	510-2625-100
C 026	.01 µF ±10% X7R chip	510-3606-103
C 027	10 µF 16V tantalum SMD	510-2625-100
C 028	10 µF 16V tantalum SMD	510-2625-100
C 029	62 pF ±5% NPO 1206 chip	510-3602-620
C 030	.01 µF ±10% X7R chip	510-3606-103
C 031	.01 µF ±10% X7R chip	510-3606-103
C 032	.01 µF ±10% X7R chip	510-3606-103
CR001	Green LED submin radial	549-4001-122
CR002	Yellow LED submin radial	549-4001-121
CR003	Red LED subminiature radial	549-4001-120
CR004	Red LED subminiature radial	549-4001-120
CR005	Yellow LED submin radial	549-4001-121
CR006	4.7V zener	523-2016-479
DS001	7-segment display .3" green	549-4002-020
EP001	Crystal pin insulator	018-1080-001
EP002	Crystal pin insulator	018-1080-001
EP003	Crystal pin insulator	018-1080-001
EP004	Crystal pin insulator	018-1080-001
HW001	Panel fastener	537-0011-031
J 001	8-cond modular jack PC mt	515-2006-040
J 002	3-pin single inline header	515-7100-003
J 003	14-pin double row header	515-7101-407
J 004	6-pin double row header	515-7101-403
J 005	3-pin single inline header	515-7100-003
J 006	3-pin single inline header	515-7100-003
P 001	64-pin DIN male right angle	515-7082-101
P 002	2-pos shorting socket	515-5010-001
P 003	2-pos shorting socket	515-5010-001
P 004	2-pos shorting socket	515-5010-001
P 005	2-pos shorting socket	515-5010-001
P 006	2-pos shorting socket	515-5010-001
PC310	PC board	035-2000-310
Q 002	PNP switching SOT-23	576-0003-612
Q 003	NPN gen purp SOT-23	576-0001-300
R 001	10M ohm ±5% 1206 SMD	569-0115-106
R 002	2.2k ohm ±5% 1206 SMD	569-0115-222
R 003	Zero ohm ±5% 1206 SMD	569-0115-001
R 004	2k ohm ±5% 1206 SMD	569-0115-202
R 005	150 ohm ±5% 1206 SMD	569-0115-151
R 006	200 ohm ±5% 1206 SMD	569-0115-201
R 007	1.2k ohm ±5% 1/4W CF	569-0115-122
R 008	1.2k ohm ±5% 1/4W CF	569-0115-122
R 009	1.2k ohm ±5% 1/4W CF	569-0115-122
R 010	200 ohm ±5% 1206 SMD	569-0115-201
R 011	1.2k ohm ±5% 1/4W CF	569-0115-122
R 012	10k ohm ±5% 1206 SMD	569-0115-103
R 013	150 ohm ±5% 1206 SMD	569-0115-151
R 014	10k ohm ±5% 1206 SMD	569-0115-103
R 015	10k ohm ±5% 1206 SMD	569-0115-103
R 016	10k ohm ±5% 1206 SMD	569-0115-103
R 017	2.2k ohm ±5% 1206 SMD	569-0115-222
R 018	2.2k ohm ±5% 1206 SMD	569-0115-222
R 019	2.2k ohm ±5% 1206 SMD	569-0115-222
R 020	2.2k ohm ±5% 1206 SMD	569-0115-222
R 021	100k ohm ±5% 1206 SMD	569-0115-104
R 022	10k ohm ±5% 1206 SMD	569-0115-103
R 023	4.7k ohm ±5% 1206 SMD	569-0115-472
R 024	4.7k ohm ±5% 1206 SMD	569-0115-472

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
R 025	10k ohm ±5% 1206 SMD	569-0115-103
R 026	10k ohm ±5% 1206 SMD	569-0115-103
R 027	10k ohm ±5% 1206 SMD	569-0115-103
R 028	4.7k ohm ±5% 1206 SMD	569-0115-472
R 029	10k ohm ±5% 1206 SMD	569-0115-103
R 030	10k ohm ±5% 1206 SMD	569-0115-103
R 031	10k ohm ±5% 1206 SMD	569-0115-103
R 032	1k ohm ±5% 1206 SMD	569-0115-102
R 033	1k ohm ±5% 1206 SMD	569-0115-102
R 034	10k ohm ±5% 1206 SMD	569-0115-103
R 035	3.9k ohm ±5% 1206 SMD	569-0115-392
R 036	Zero ohm ±5% 1206 SMD	569-0115-001
R 037	Zero ohm ±5% 1206 SMD	569-0115-001
R 038	20k ohm ±5% 1206 SMD	569-0115-203
R 039	270k ohm ±5% 1206 SMD	569-0115-274
S 001	Push-button momentary sw	583-4005-002
S 002	8-pos DIP switch	583-5002-008
S 003	4-pos DIP switch	583-5002-004
U 001	8k x 8 CMOS static RAM	544-5001-109
U 002	Hex inverter SOIC 74HC04	544-3766-004
U 003	1 of 8 demux 74HC138	544-3766-138
U 004	1 of 8 demux 74HC138	544-3766-138
U 005	1 of 16 demux SOIC 74HC154	544-3766-154
U 006	Quad 2-input OR 74HC32	544-3766-032
U 007	Quad 2-input OR 74HC32	544-3766-032
U 008	D-latch non-inv 74HC573	544-3766-573
U 009	9 bit x 64 word FIFO DIP-28	544-3764-703
U 010	9 bit x 64 word FIFO DIP-28	544-3764-703
U 011	12V regulator TO-92 78L12	544-2003-032
U 012	12V regulator TO-92 78L12	544-2003-032
U 013	8k ROM masked DIP-40 8052	544-5010-448
U 014	HSDB Multi-Net software	023-9998-289
U 015	Hex open drain buffer SO-14	544-3716-906
U 016	Driver/receiver RS232C/v28	544-2023-014
U 017	Micro monitor SO-8 DS1232	544-2003-085
U 018	32 x 8 SCRAM SO-28 CMOS	544-5001-412
U 019	Triple line receiver	544-2023-003
U 020	Quad 2-input NAND 74HC00	544-3766-000
U 021	7-stage binary cntr SOIC 4024	544-3016-024
U 022	Prog comm intfc 82C51	544-5001-319
U 023	Differential bus xcvr 65176	544-2023-025
U 024	Differential bus xcvr 65176	544-2023-025
U 025	MPC boot code	023-9998-277
U 026	BCD 7-latch DIP-16 14495	544-3014-495
U 027	CPU v25 PLCC-84 7032	544-5002-016
U 028	EEPROM PLCC32R 28C64	544-5002-412
U 029	Dual inline driver	544-2023-002
X 001	10-pos right angle IC socket	515-5008-270
X 014	28-pin IC socket	515-5008-018
X 013	40-pin IC socket	515-5008-019
X 024	8-pin DIP socket	515-5008-011
X 025	32-pin IC socket	515-5008-108
X 027	84-pos PLCC socket	515-5020-100
Y 001	10 MHz crystal HC-18	521-0010-000
Y 002	11.059 MHz crystal	521-0011-059
Y 003	2.4576 MHz HC-18U	521-0002-458
Y 004	12 MHz µP crystal	521-0012-000
Z 001	EMI suppression filter	532-3003-002
Z 002	EMI suppression filter	532-3003-002

MAIN AUDIO CARD
PART NO. 023-2000-320

A 301	Compandor option	023-2000-940
C 100	470 pF ±5% NPO 1206 chip	510-3602-471
C 101	.0022 µF ±10% X7R 1206 chip	510-3606-222
C 102	.001 µF ±2% NPO 1206	510-3616-102
C 103	.1 µF ±10% X7R chip	510-3606-104
C 104	100 pF ±2% NPO 1206	510-3616-101
C 105	.033 µF ±5% X7R 1210	510-3610-333
C 106	.068 µF ±5% X7R 1206	510-3609-683
C 107	.022 µF ±5% X7R 1206	510-3609-223
C 108	.1 µF ±5% X7R 1206	510-3609-104
C 109	.1 µF ±5% X7R 1206	510-3609-104
C 110	.022 µF ±5% X7R 1206	510-3609-223
C 111	.022 µF ±5% X7R 1206	510-3609-223
C 112	.01 µF ±5% X7R 1206	510-3609-103
C 113	100 pF ±5% NPO 1206 chip	510-3602-101
C 114	100 pF ±5% NPO 1206 chip	510-3602-101
C 115	100 pF ±5% NPO 1206 chip	510-3602-101
C 116	.001 µF ±5% NPO 1206	510-3602-102
C 117	.01 µF ±5% X7R 1206	510-3609-103
C 118	.01 µF ±5% X7R 1206	510-3609-103
C 119	.1 µF ±5% X7R 1206	510-3609-104
C 120	.1 µF ±5% X7R 1206	510-3609-104
C 121	.01 µF ±5% X7R 1206	510-3609-103
C 122	.022 µF ±5% X7R 1206	510-3609-223
C 123	.047 µF ±5% X7R 1206	510-3609-473

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
C 124	.0068 µF ±10% X7R chip	510-3606-682
C 125	680 pF ±2% NPO 1206	510-3616-681
C 126	.01 µF ±2% NPO 1206	510-3617-103
C 127	680 pF ±2% NPO 1206	510-3616-681
C 128	.0033 µF ±2% NPO 1206	510-3616-332
C 129	470 pF ±2% NPO 1206	510-3616-471
C 130	470 pF ±2% NPO 1206	510-3616-471
C 131	.0047 µF ±5% X7R 1206	510-3609-472
C 132	.0056 µF ±2% NPO 1206	510-3617-562
C 133	.0047 µF ±2% NPO 1206	510-3616-472
C 134	20 pF ±5% NPO 1206 chip	510-3602-200
C 136	100 pF ±5% NPO 1206	510-3602-101
C 137	100 pF ±5% NPO 1206	510-3602-101
C 138	.1 µF ±10% X7R chip	510-3606-104
C 139	.1 µF ±10% X7R chip	510-3606-104
C 140	.1 µF ±10% X7R chip	510-3606-104
C 141	.1 µF ±10% X7R chip	510-3606-104
C 142	.01 µF ±5% X7R 1206	510-3609-103
C 143	.022 µF ±5% X7R 1206	510-3609-223
C 144	.047 µF ±10% X7R 1206	510-3606-473
C 145	.0068 µF ±5% X7R 1206	510-3609-682
C 146	390 pF ±5% NPO 1206	510-3602-391
C 147	4700 pF ±2% NPO 1206	510-3616-681
C 148	.01 µF ±2% NPO 1206	510-3617-103
C 149	4700 pF ±2% NPO 1206	510-3616-472
C 150	.022 µF ±5% X7R 1206	510-3609-223
C 151	.1 µF ±10% X7R chip	510-3606-104
C 152	.1 µF ±10% X7R chip	510-3606-104
C 153	.1 µF ±10% X7R chip	510-3606-104
C 154	.1 µF ±10% X7R chip	510-3606-104
C 155	2200 pF ±5% NPO 1206 chip	510-3602-222
C 156	.1 µF ±10% X7R chip	510-3606-104
C 157	10 pF ±5% NPO 1206 chip	510-3602-100
C 158	10 pF ±5% NPO 1206 chip	510-3602-100
C 159	.047 µF ±10% X7R chip	510-3606-473
C 160	.1 µF ±10% X7R chip	510-3606-104
C 161	.1 µF ±10% X7R chip	510-3606-104
C 162	20 pF ±5% NPO 1206 chip	510-3602-200
C 163	20 pF ±5% NPO 1206 chip	510-3602-200
C 164	.001 µF ±2% NPO 1206	510-3616-102
C 165	360 pF ±5% NPO 1206	510-3602-361
C 170	.01 µF ±10% X7R chip	510-3606-103
C 171	.01 µF ±10% X7R chip	510-3606-103
C 172	.01 µF ±10% X7R chip	510-3606-103
C 173	.01 µF ±10% X7R chip	510-3606-103
C 174	.01 µF ±10% X7R chip	510-3606-103
C 175	.01 µF ±10% X7R chip	510-3606-103
C 176	.01 µF ±10% X7R chip	510-3606-103
C 177	.01 µF ±10% X7R chip	510-3606-103
C 178	.01 µF ±10% X7R chip	510-3606-103
C 179	.01 µF ±10% X7R chip	510-3606-103
C 180	.01 µF ±10% X7R chip	510-3606-103
C 181	.01 µF ±10% X7R chip	510-3606-103
C 182	.01 µF ±10% X7R chip	510-3606-103
C 183	.01 µF ±10% X7R chip	510-3606-103
C 184	.01 µF ±10% X7R chip	510-3606-103
C 185	.01 µF ±10% X7R chip	510-3606-103
C 186	.01 µF ±10% X7R chip	510-3606-103
C 187	.01 µF ±10% X7R chip	510-3606-103
C 188	.01 µF ±10% X7R chip	510-3606-103
C 189	.01 µF ±10% X7R chip	510-3606-103
C 190	.01 µF ±10% X7R chip	510-3606-103
C 191	.01 µF ±10% X7R chip	510-3606-103
C 192	.01 µF ±10% X7R chip	510-3606-103
C 193	.01 µF ±10% X7R chip	510-3606-103
C 194	.01 µF ±10% X7R chip	510-3606-103
C 195	.01 µF ±10% X7R chip	510-3606-103
C 196	.01 µF ±10% X7R chip	510-3606-103
C 197	.01 µF ±10% X7R chip	510-3606-103
C 198	.01 µF ±10% X7R chip	510-3606-103
C 199	.01 µF ±10% X7R chip	510-3606-103
C 200	.01 µF ±10% X7R chip	510-3606-103
C 201	.01 µF ±10% X7R chip	510-3606-103
C 202	.01 µF ±10% X7R chip	510-3606-103
C 203	.01 µF ±10% X7R chip	510-3606-103
C 204	.01 µF ±10% X7R chip	510-3606-103
C 205	.01 µF ±10% X7R chip	510-3606-103
C 206	.01 µF ±10% X7R chip	510-3606-103
C 207	1 µF tantalum SMD	510-2625-109
C 208	.01 µF ±10% X7R chip	510-3606-103
C 209	.01 µF ±10% X7R chip	510-3606-103
C 210	.01 µF ±10% X7R chip	510-3606-103
C 211	.01 µF ±10% X7R chip	510-3606-103
C 212	.01 µF ±10% X7R chip	510-3606-103
C 213	.01 µF ±10% X7R chip	510-3606-103
C 214	.01 µF ±10% X7R chip	510-3606-103
C 215	.01 µF ±10% X7R chip	510-3606-103
C 216	.01 µF ±10% X7R chip	510-3606-103
C 217	.01 µF ±10% X7R chip	510-3606-103
C 218	.01 µF ±10% X7R chip	510-3606-103
C 219	.01 µF ±10% X7R chip	510-3606-103
C 220	.01 µF ±10% X7R chip	510-3606-103
C 221	.01 µF ±10% X7R chip	510-3606-103
C 222	.01 µF ±10% X7R chip	510-3606-103

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
C 223	.01 µF ±10% X7R chip	510-3606-103
C 224	.01 µF ±10% X7R chip	510-3606-103
C 225	.01 µF ±10% X7R chip	510-3606-103
C 226	.01 µF ±10% X7R chip	510-3606-103
C 227	.01 µF ±10% X7R chip	510-3606-103
C 228	.01 µF ±10% X7R chip	510-3606-103
C 229	.01 µF ±10% X7R chip	510-3606-103
C 230	.01 µF ±10% X7R chip	510-3606-103
C 231	.01 µF ±10% X7R chip	510-3606-103
C 232	.01 µF ±10% X7R chip	510-3606-103
C 233	.01 µF ±10% X7R chip	510-3606-103
C 234	.01 µF ±10% X7R chip	510-3606-103
C 235	1 µF tantalum SMD	510-2625-109
C 236	.001 pF ±2% NPO 1206	510-3616-102
C 237	.033 µF ±5% X7R 1210	510-3610-333
C 238	.047 µF ±5% X7R 1206	510-3609-473
C 239	.068 µF ±5% X7R 1206	510-3609-683
C 240	1 µF tantalum SMD	510-2625-109
C 241	15 µF 20V tantalum SMD	510-2626-150
C 242	15 µF 20V tantalum SMD	510-2626-150
C 243	10 µF 63V axial low temp	510-4363-100
C 244	10 µF 63V axial low temp	510-4363-100
C 245	10 µF 63V axial low temp	510-4363-100
C 246	10 µF 63V axial low temp	510-4363-100
C 247	1 µF tantalum SMD	510-2625-109
C 248	10 µF 16V tantalum SMD	510-2625-100
C 249	.1 µF ±10% X7R chip	510-3606-104
C 251	15 µF 20V tantalum SMD	510-2626-150
C 254	.1 µF ±10% X7R 1206	510-3606-104
C 255	47 µF 10V tantalum SMD	510-2624-470
C 256	15 µF 20V tantalum SMD	510-2626-150
C 257	47 µF 10V tantalum SMD	510-2624-470
C 258	47 µF 10V tantalum SMD	510-2624-470
C 262	.01 µF ±10% X7R chip	510-3606-103
C 263	.01 µF ±10% X7R chip	510-3606-103
C 264	.01 µF ±10% X7R chip	510-3606-103
C 265	.01 µF ±10% X7R chip	510-3606-103
C 266	.01 µF ±10% X7R chip	510-3606-103
C 267	47 µF 10V tantalum SMD	510-2624-470
C 268	47 µF 10V tantalum SMD	510-2624-470
C 269	47 µF 10V tantalum SMD	510-2624-470
C 270	47 µF 10V tantalum SMD	510-2624-470
C 271	.01 µF ±10% X7R chip	510-3606-103
C 272	.01 µF ±10% X7R chip	510-3606-103
C 273	.01 µF ±10% X7R chip	510-3606-103
C 276	.0022 µF ±2% NPO 1206	510-3616-222
C 277	.0047 µF ±2% NPO 1206	510-3616-472
C 278	.0068 µF ±2% NPO 1206	510-3617-682
C 279	.22 µF ±5% X7R 1210	510-3610-224
C 280	.022 µF ±5% X7R 1206	510-3609-223
C 281	820 pF ±2% NPO 1206	510-3616-821
C 282	.1 µF ±10% X7R 1206	510-3606-104
C 283	.1 µF ±10% X7R 1206	510-3606-104
C 284	220 µF electrolytic axial	510-4325-221
C 285	470 µF electrolytic axial	510-4316-471
C 286	10 µF tantalum SMD	510-2625-100
C 287	300 pF ±5% NPO 1206	510-3602-301
C 288	300 pF ±5% NPO 1206	510-3602-301
C 289	300 pF ±5% NPO 1206	510-3602-301
C 290	300 pF ±5% NPO 1206	510-3602-301
C 291	.1 µF ±5% X7R 1206	510-3609-104
C 292	360 pF ±5% NPO 1206	510-3602-361
C 293	68 pF ±5% NPO 1206	510-3602-680
C 294	.1 µF ±5% X7R 1206	510-3609-104
C 295	220 µF electrolytic aluminum	510-4325-221
C 296	10 µF 16V tantalum SMD	510-2625-100
C 297	.0039 µF ±2% NPO 1206	510-3616-392
C 298	.0033 µF ±2% NPO 1206	510-3616-332
C 299	.01 µF ±10% X7R chip	510-3606-103
C 300	.0056 µF ±2% NPO 1210	510-3617-562
C 301	.0047 µF ±2% NPO 1206	510-3616-472
C 302	.0033 µF ±2% NPO 1206	510-3616-332
C 303	.0039 µF ±2% NPO 1206	510-3616-392
C 304	.1 µF ±10% X7R 1206 chip	510-3606-104
C 305	10 µF tantalum SMD	510-2625-100
CR100	Switching diode SOT-23	523-1504-002
CR101	Dual switching diode SOT-23	523-1504-023
CR102	Dual switching diode SOT-23	523-1504-023
CR103	Dual switching diode SOT-23	523-1504-023
CR104	Dual switching diode SOT-23	523-1504-023
CR105	Dual switching diode SOT-23	523-1504-023
CR106	Switching diode SOT-23	523-1504-002
CR107	4.3V zener SOT-23	523-2016-439
CR108	UHF/VHF band switch SOT	523-1504-012
CR109	UHF/VHF band switch SOT	523-1504-012
CR110	UHF/VHF band switch SOT	523-1504-012
CR111	2.4V 1W zener	523-2505-249
CR112	2.4V 1W zener	523-2505-249
CR113	15V zener SOT-23	523-2016-150
CR114	15V zener SOT-23	523-2016-150
CR117	15V zener SOT-23	523-2016-150
CR118	15V zener SOT-23	523-2016-150
CR119	5.1V zener SOT-23	523-2016-519

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
CR120	5.1V zener SOT-23	523-2016-519
EP100	Crystal pin insulator	018-1080-001
HW001	Panel fastener	537-0011-031
HW101	Card inj/ext nylon pull	537-9057-020
HW102	Rivet snap 0.142 dia	574-9015-050
HW103	PC board ejector & handle	537-9057-025
J 100	Green horizontal tip jack .080	105-2204-105
J 101	Speaker jack 0.1 enclosed	515-2002-012
J 102	3.6mm jack enclosed	515-2001-011
J 103	Black horiz tip jack .080	105-2203-101
J 104	3.6mm jack enclosed	515-2001-011
J 105	3-pin single inline header	515-7100-003
J 106	5-pin single inline header	515-7100-005
MP001	Control knob	032-0792-010
P 100	32-pin DIN male right angle	515-7082-102
P 101	64-pin DIN male right angle	515-7082-101
P 102	2-pos shorting socket	515-5010-001
PC200	PC board	035-2000-320
Q 101	Si PNP SOT-23 2N3906	576-0003-657
Q 102	Si NPN SOT-23 2N3904	576-0003-658
R 101	29.4k ohm ±1% 1206 SMD	569-0111-446
R 102	147k ohm ±1% 1206 SMD	569-0111-517
R 103	69.8k ohm ±1% 1206 SMD	569-0111-482
R 104	15k ohm ±1% 1206 SMD	569-0111-418
R 105	100 ohm ±1% 1206 SMD	569-0111-201
R 106	1.07M ohm ±1% 1206 SMD	569-0111-604
R 107	1.07M ohm ±1% 1206 SMD	569-0111-604
R 108	110 ohm ±1% 1206 SMD	569-0111-205
R 109	1.07M ohm ±1% 1206 SMD	569-0111-604
R 110	110 ohm ±1% 1206 SMD	569-0111-205
R 111	18.2k ohm ±1% 1206 SMD	569-0111-426
R 112	47k ohm ±5% 1206 SMD	569-0115-473
R 113	150k ohm ±5% 1206 SMD	569-0115-154
R 114	18k ohm ±5% 1206 SMD	569-0115-183
R 115	47k ohm ±5% 1206 SMD	569-0115-473
R 116	1.5k ohm ±5% 1206 SMD	569-0115-152
R 117	6.2k ohm ±5% 1206 SMD	569-0115-622
R 118	12k ohm ±5% 1206 SMD	569-0115-123
R 119	47k ohm ±5% 1206 SMD	569-0115-473
R 120	10k ohm ±5% 1206 SMD	569-0115-103
R 121	47k ohm ±5% 1206 SMD	569-0115-473
R 122	10k ohm ±5% 1206 SMD	569-0115-103
R 123	330k ohm ±5% 1206 SMD	569-0115-334
R 124	1M ohm ±5% 1206 SMD	569-0115-105
R 125	100k ohm ±5% 1206 SMD	569-0115-104
R 126	100k ohm ±5% 1206 SMD	569-0115-104
R 127	470k ohm ±5% 1206 SMD	569-0115-474
R 128	100k ohm ±5% 1206 SMD	569-0115-104
R 129	47k ohm ±5% 1206 SMD	569-0115-473
R 130	100k ohm ±5% 1206 SMD	569-0115-104
R 131	56k ohm ±5% 1206 SMD	569-0115-563
R 132	56k ohm ±5% 1206 SMD	569-0115-563
R 133	100k ohm ±5% 1206 SMD	569-0115-104
R 134	100k ohm ±5% 1206 SMD	569-0115-104
R 135	47k ohm ±5% 1206 SMD	569-0115-473
R 136	10k ohm ±5% 1206 SMD	569-0115-103
R 137	121k ohm ±1% 1206 SMD	569-0111-509
R 138	121k ohm ±1% 1206 SMD	569-0111-509
R 139	35.7k ohm ±1% 1206 SMD	569-0111-454
R 140	27.4k ohm ±1% 1206 SMD	569-0111-443
R 141	22.6k ohm ±1% 1206 SMD	569-0111-435
R 142	17.4k ohm ±1% 1206 SMD	569-0111-424
R 143	3.3k ohm ±5% 1206 SMD	569-0115-332
R 144	1k ohm ±5% 1206 SMD	569-0115-102
R 145	150k ohm ±5% 1206 SMD	569-0115-154
R 150	86.6k ohm ±1% 1206 SMD	569-0111-491
R 151	43.2k ohm ±1% 1206 SMD	569-0111-462
R 152	22k ohm ±5% 1206 SMD	569-0115-223
R 153	43k ohm ±5% 1206 SMD	569-0115-433
R 154	43k ohm ±5% 1206 SMD	569-0115-433
R 155	82k ohm ±5% 1206 SMD	569-0115-823
R 156	82k ohm ±5% 1206 SMD	569-0115-823
R 157	82k ohm ±5% 1206 SMD	569-0115-823
R 158	82k ohm ±5% 1206 SMD	569-0115-823
R 159	2.74k ohm ±1% 1206 SMD	569-0111-343
R 160	1.1k ohm ±1% 1206 SMD	569-0111-305
R 161	3.01k ohm ±1% 1206 SMD	569-0111-347
R 162	18.2k ohm ±1% 1206 SMD	569-0111-426
R 163	100k ohm ±5% 1206 SMD	569-0115-104
R 164	100k ohm ±5% 1206 SMD	569-0115-104
R 165	47k ohm ±5% 1206 SMD	569-0115-473
R 166	56k ohm ±5% 1206 SMD	569-0115-563
R 167	56k ohm ±5% 1206 SMD	569-0115-563
R 168	2.2k ohm ±5% 1206 SMD	569-0115-222
R 169	54.9k ohm ±1% 1206 SMD	569-0111-472
R 170	1M ohm ±5% 1206 SMD	569-0115-105
R 171	10k ohm ±5% 1206 SMD	569-0115-103

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
R 172	10k ohm ±5% 1206 SMD	569-0115-103
R 173	430k ohm ±5% 1206 SMD	569-0115-434
R 174	160k ohm ±5% 1206 SMD	569-0115-164
R 175	4.3k ohm ±5% 1206 SMD	569-0115-432
R 176	6.8k ohm ±5% 1206 SMD	569-0115-682
R 177	100k ohm ±5% 1206 SMD	569-0115-104
R 178	100k ohm ±5% 1206 SMD	569-0115-104
R 179	300 ohm ±5% 1206 SMD	569-0115-301
R 180	300 ohm ±5% 1206 SMD	569-0115-301
R 181	100k ohm ±5% 1206 SMD	569-0115-104
R 182	100k ohm ±5% 1206 SMD	569-0115-104
R 183	300 ohm ±5% 1206 SMD	569-0115-301
R 184	300 ohm ±5% 1206 SMD	569-0115-301
R 185	75k ohm ±1% 1206 SMD	569-0111-485
R 186	75k ohm ±1% 1206 SMD	569-0111-485
R 187	75k ohm ±1% 1206 SMD	569-0111-485
R 188	75k ohm ±1% 1206 SMD	569-0111-485
R 189	300 ohm ±5% 1206 SMD	569-0115-301
R 190	300 ohm ±5% 1206 SMD	569-0115-301
R 191	75k ohm ±1% 1206 SMD	569-0111-485
R 192	75k ohm ±1% 1206 SMD	569-0111-485
R 193	75k ohm ±1% 1206 SMD	569-0111-485
R 194	75k ohm ±1% 1206 SMD	569-0111-485
R 195	300 ohm ±5% 1206 SMD	569-0115-301
R 196	300 ohm ±5% 1206 SMD	569-0115-301
R 197	910 ohm ±5% 1206 SMD	569-0115-911
R 198	100k ohm ±5% 1206 SMD	569-0115-104
R 199	10k ohm ±5% 1206 SMD	569-0115-103
R 200	1M ohm ±5% 1206 SMD	569-0115-105
R 201	270k ohm ±5% 1206 SMD	569-0115-274
R 202	1M ohm ±5% 1206 SMD	569-0115-105
R 203	620 ohm ±5% 1206 SMD	569-0115-621
R 204	47k ohm ±5% 1206 SMD	569-0115-473
R 205	7.5k ohm ±5% 1206 SMD	569-0115-752
R 206	10k ohm ±5% 1206 SMD	569-0115-103
R 207	10k ohm ±5% 1206 SMD	569-0115-103
R 208	10k ohm ±5% 1206 SMD	569-0115-103
R 209	10k ohm ±5% 1206 SMD	569-0115-103
R 210	10k ohm ±5% 1206 SMD	569-0115-103
R 211	100 ohm ±5% 1206 SMD	569-0115-101
R 212	1k ohm ±5% 1206 SMD	569-0115-102
R 213	5.1k ohm ±5% 1206 SMD	569-0115-512
R 214	3.9k ohm ±5% 1206 SMD	569-0115-392
R 215	1k ohm ±5% 1206 SMD	569-0115-102
R 216	10k ohm ±5% 1206 SMD	569-0115-103
R 217	100 ohm ±5% 1206 SMD	569-0115-101
R 218	82k ohm ±5% 1206 SMD	569-0115-823
R 219	180k ohm ±5% 1206 SMD	569-0115-184
R 220	16k ohm ±5% 1206 SMD	569-0115-163
R 223	6.8k ohm ±5% 1206 SMD	569-0115-682
R 225	10k ohm ±5% 1206 SMD	569-0115-103
R 226	10k ohm ±5% 1206 SMD	569-0115-103
R 227	10k ohm ±5% 1206 SMD	569-0115-103
R 228	5.1k ohm ±1% 1206 SMD	569-0111-512
R 229	1k ohm ±5% 1206 SMD	569-0115-102
R 230	7.5k ohm ±5% 1206 SMD	569-0115-752
R 231	10k ohm ±5% 1206 SMD	569-0115-103
R 232	100 ohm ±5% 1/4W CF	569-0513-101
R 233	100k ohm multi-turn pot	562-0110-104
R 234	100k ohm multi-turn pot	562-0110-104
R 235	100k ohm multi-turn pot	562-0110-104
R 236	10k ohm Vol/Audio switch	562-0018-044
R 237	100k ohm multi-turn pot	562-0110-104
R 238	100k ohm multi-turn pot	562-0110-104
R 239	100k ohm multi-turn pot	562-0110-104
R 240	100k ohm multi-turn pot	562-0110-104
R 241	100k ohm multi-turn pot	562-0110-104
R 242	100k ohm multi-turn pot	562-0110-104
R 243	100k ohm multi-turn pot	562-0110-104
R 244	100k ohm multi-turn pot	562-0110-104
R 247	54.9k ohm ±1% 1206 SMD	569-0111-472
R 248	120k ohm ±5% 1206 SMD	569-0115-124
R 249	36k ohm ±5% 1206 SMD	569-0115-363
R 250	270k ohm ±5% 1206 SMD	569-0115-274
R 251	51k ohm ±5% 1206 SMD	569-0115-513
R 252	43k ohm ±5% 1206 SMD	569-0115-433
R 253	390k ohm ±5% 1206 SMD	569-0115-394
R 254	47k ohm ±5% 1206 SMD	569-0115-473
R 256	36k ohm ±5% 1206 SMD	569-0115-363
R 257	36k ohm ±5% 1206 SMD	569-0115-363
R 258	2.2k ohm ±5% 1206 SMD	569-0115-222
R 259	10k ohm ±5% 1206 SMD	569-0115-103
R 260	36k ohm ±5% 1206 SMD	569-0115-363
R 261	300k ohm ±5% 1206 SMD	569-0115-304
R 262	2.2k ohm ±5% 1206 SMD	569-0115-222
R 263	10k ohm ±5% 1206 SMD	569-0115-103
R 264	10k ohm ±5% 1206 SMD	569-0115-103
R 265	2.2k ohm ±5% 1206 SMD	569-0115-222
R 266	10k ohm ±5% 1206 SMD	569-0115-103
R 267	2.2k ohm ±5% 1206 SMD	569-0115-222
R 268	36k ohm ±5% 1206 SMD	569-0115-363
R 269	36k ohm ±5% 1206 SMD	569-0115-363
R 270	39k ohm ±5% 1206 SMD	569-0115-393
R 271	180k ohm ±5% 1206 SMD	569-0115-184

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
R 274	36k ohm ±5% 1206 SMD	569-0115-363
R 275	36k ohm ±5% 1206 SMD	569-0115-363
R 276	18k ohm ±5% 1206 SMD	569-0115-183
R 277	5.1k ohm ±5% 1206 SMD	569-0115-512
R 279	150k ohm ±5% 1206 SMD	569-0115-154
R 280	150k ohm ±5% 1206 SMD	569-0115-154
R 281	1M ohm ±5% 1206 SMD	569-0115-105
R 282	10k ohm ±5% 1206 SMD	569-0115-103
R 283	Zero ohm ±5% 1206 SMD	569-0115-001
R 284	10k ohm ±5% 1206 SMD	569-0115-103
R 285	2.2k ohm ±5% 1206 SMD	569-0115-222
R 286	75k ohm ±5% 1206 SMD	569-0115-753
R 287	100 ohm ±5% 1/4W CF	569-0513-101
R 288	220 ohm ±5% 1206 SMD	569-0115-221
R 289	2.2 ohm ±10% 1206 SMD	569-0115-229
R 290	1 ohm ±10% 1206 SMD	569-0115-109
R 291	1k ohm ±5% 1206 SMD	569-0115-102
R 292	39 ohm ±5% 1206 SMD	569-0115-390
R 293	6.2k ohm ±5% 1206 SMD	569-0115-622
R 294	1k ohm ±5% 1206 SMD	569-0115-102
R 295	10k ohm ±5% 1206 SMD	569-0115-103
R 296	10k ohm ±5% 1206 SMD	569-0115-103
R 297	10k ohm ±5% 1206 SMD	569-0115-103
R 298	10k ohm ±5% 1206 SMD	569-0115-103
R 299	10k ohm ±5% 1206 SMD	569-0115-103
R 300	36k ohm ±5% 1206 SMD	569-0115-363
R 301	100k ohm multi-turn pot	562-0110-104
R 302	36k ohm ±5% 1206 SMD	569-0115-363
R 303	240 ohm ±5% 1206 SMD	569-0115-241
R 304	27 ohm ±5% 1206 SMD	569-0115-270
R 305	100k ohm multi-turn pot	562-0110-104
R 306	36k ohm ±5% 1206 SMD	569-0115-363
R 307	36k ohm ±5% 1206 SMD	569-0115-363
R 308	909k ohm ±1% 1206 SMD	569-0111-593
R 309	25.5k ohm ±1% 1206 SMD	569-0111-440
R 310	Zero ohm ±10% 1206 SMD	569-0115-001
R 311	Zero ohm ±10% 1206 SMD	569-0115-001
R 312	Zero ohm ±10% 1206 SMD	569-0115-001
R 313	Zero ohm ±10% 1206 SMD	569-0115-001
R 314	43.2k ohm ±1% 1206 SMD	569-0111-462
R 315	86.6k ohm ±1% 1206 SMD	569-0111-491
R 316	25.5k ohm ±1% 1206 SMD	569-0111-440
R 317	909k ohm ±1% 1206 SMD	569-0111-593
R 318	10k ohm ±5% 1206 SMD	569-0115-103
R 319	10k ohm ±5% 1206 SMD	569-0115-103
R 320	180k ohm ±5% 1206 SMD	569-0115-184
R 321	100 ohm ±5% 1206 SMD	569-0115-101
R 322	Zero ohm ±5% 1206 SMD	569-0115-001
R 323	Zero ohm ±5% 1206 SMD	569-0115-001
RT100	10k ohm chip thermistor	569-3013-007
S 100	8-pos DIP switch	583-5002-008
S 101	4-pos DIP switch	583-5002-004
U 100	Quad 2-input NOR	544-3766-002
U 101	Hex inverter SOIC 74HC04	544-3766-004
U 102	1 of 8 demux 74HC138	544-3766-138
U 103	1 of 16 demux SOIC 74HC154	544-3766-154
U 104	D-latch non-inverting SOIC	544-3766-573
U 105	D-latch non-inverting SOIC	544-3766-573
U 106	D flip flop SOIC 74HC574	544-3766-574
U 107	D flip flop SOIC 74HC574	544-3766-574
U 108	D flip flop SOIC 74HC574	544-3766-574
U 111	EEPROM masked DIP-40	544-5010-448
U 112	Main Audio Card/LTR	023-9998-291
U 113	Quad analog sw SPST SO-16	544-3003-001
U 114	Quad analog sw SPST SO-16	544-3003-001
U 115	Quad analog sw SPST SO-16	544-3003-001
U 116	Quad analog sw SPST SO-16	544-3003-001
U 117	Quad analog sw SPST SO-16	544-3003-001
U 118	Quad analog sw SPST SO-16	544-3003-001
U 119	Micro monitor SO-8 DS1232	544-2003-085
U 120	Dual op amp SOIC LM2904	544-2019-004
U 121	Dual op amp SOIC LM2904	544-2019-004
U 122	Quad op amp SOIC MC3403	544-2020-008
U 123	Quad op amp SOIC MC3403	544-2020-008
U 124	Dual op amp SOIC LM2904	544-2019-004
U 125	Quad op amp SOIC MC3404	544-2020-008
U 126	Quad op amp SOIC MC3404	544-2020-008
U 127	Quad op amp SOIC MC3404	544-2020-008
U 128	Quad op amp SOIC MC3404	544-2020-008
U 129	Quad op amp SOIC MC3404	544-2020-008
U 130	Dual op amp SOIC LM2904	544-2019-004
U 131	Quad op amp SOIC MC3404	544-2020-008
U 132	Audio amp 10W TO-220	544-2006-013
U 133	1 of 16 demux SOIC 74HC154	544-3766-154
U 135	Dual op amp SO-8 MC33178	544-2019-018
U 136	+5V regulator SOIC 78L08	544-2603-042
U 149	EEPOT 100k SOIC 9C104	544-0004-209
U 151	EEPOT 100k SOIC 9C104	544-0004-209
U 153	Quad analog sw SPST SO-16	544-3003-001
U 154	Quad 2-in OR SOIC 74HC32	544-3766-032
U 155	D flip flop SOIC 74HC574	544-3766-574

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
U 156	D flip flop SOIC 74HC574	544-3766-574
U 157	D flip flop SOIC 74HC574	544-3766-574
U 158	Quad analog sw SOIC DG202	544-3003-001
U 159	Quad analog sw SOIC DG202	544-3003-001
U 160	9 bit x 64 word FIFO DIP-28	544-3764-703
U 161	9 bit x 64 word FIFO DIP-28	544-3764-703
U 162	Dr/Rcvr RS232C V.28 145406	544-2023-014
U 163	Dual op amp SOIC LM2904	544-2019-004
U 164	Dual op amp SOIC LM2904	544-2019-004
U 165	Dual op amp SOIC LM2904	544-2019-004
U 166	Dual op amp SO-8 MC33178	544-2019-018
U 167	Quad op amp SOIC MC3404	544-2020-008
X 111	40-pin IC socket	515-5008-019
X 112	28-pin IC socket	515-5008-018
Y 100	2.4576 MHz crystal HC-18U	521-0002-458
Y 101	11.059 MHz crystal	521-0011-059
Z 100	EMI suppression filter	532-3003-002
Z 101	EMI suppression filter	532-3003-002
Z 102	EMI suppression filter	532-3003-002

INTERFACE ALARM CARD
PART NO. 023-2000-350

C 500	.01 µF ±10% X7R chip	510-3606-103
C 501	.015 µF ±10% X7R chip	510-3606-153
C 502	.1 µF ±10% X7R 1210	510-3607-104
C 503	150 pF ±5% NPO 1206 chip	510-3602-151
C 504	10 µFD 16V tantalum SMD	510-2625-100
C 505	10 µFD 16V tantalum SMD	510-2625-100
C 506	10 µFD 16V tantalum SMD	510-2625-100
C 507	10 µFD 16V tantalum SMD	510-2625-100
C 508	33 µF 10V tantalum SMD	510-2624-330
C 509	1 µF 16V tantalum SMD	510-2625-109
C 510	33 µF 10V tantalum SMD	510-2624-330
C 511	.01 µF ±10% X7R chip	510-3606-103
C 512	.01 µF ±10% X7R chip	510-3606-103
C 513	.01 µF ±10% X7R chip	510-3606-103
C 514	.01 µF ±10% X7R chip	510-3606-103
C 515	.01 µF ±10% X7R chip	510-3606-103
C 516	.01 µF ±10% X7R chip	510-3606-103
C 517	.01 µF ±10% X7R chip	510-3606-103
C 518	.01 µF ±10% X7R chip	510-3606-103
C 519	.01 µF ±10% X7R chip	510-3606-103
C 520	.1 µF ±10% X7R chip	510-3607-104
C 521	.01 µF ±10% X7R chip	510-3606-103
C 522	47 µF 25V electrolytic radial	510-4425-470
C 523	47 µF 25V electrolytic radial	510-4425-470
C 524	10 µFD 16V tantalum SMD	510-2625-100
C 525	10 µFD 16V tantalum SMD	510-2625-100
C 526	1 µF 16V tantalum SMD	510-2625-109
C 527	.1 µF 35V tantalum SMD	510-2628-108
C 528	.01 µF ±10% X7R chip	510-3606-103
C 529	.01 µF ±10% X7R chip	510-3606-103
C 530	220 µF 25V aluminum radial	510-4225-221
C 531	.01 µF ±10% X7R chip	510-3606-103
C 532	1000 µF 25V aluminum radial	510-4225-102
C 533	.01 µF ±10% X7R chip	510-3606-103
C 534	100 pF ±5% NPO 1206	510-3602-101
C 535	100 pF ±5% NPO 1206	510-3602-101
C 536	.1 µF ±10% X7R 1210	510-3607-104
C 537	.1 µF ±10% X7R 1210	510-3607-104
C 538	.01 µF ±10% X7R chip	510-3606-103
C 539	.01 µF ±10% X7R chip	510-3606-103
CR500	Red LED submin radial	549-4001-120
CR501	Green LED submin radial	549-4001-122
CR502	Yellow LED submin radial	549-4001-121
CR503	Green LED submin radial	549-4001-122
CR504	Green LED submin radial	549-4001-122
CR505	Yellow LED submin radial	549-4001-121
CR506	Dual switch diode SOT-23	523-1504-023
CR507	Dual switch diode SOT-23	523-1504-023
CR508	Dual switch diode SOT-23	523-1504-023
CR509	Dual switch diode SOT-23	523-1504-023
CR510	Dual switch diode SOT-23	523-1504-023
CR511	Dual switch diode SOT-23	523-1504-023
CR512	Dual switch diode SOT-23	523-1504-023
CR513	Dual switch diode SOT-23	523-1504-023
CR522	5.1V zener SOT-23	523-2016-519
CR523	Green LED submin radial	549-4001-122
CR524	Green LED submin radial	549-4001-122
CR525	Green LED submin radial	549-4001-122
CR526	200V 1.5A rectifier 1N4818	523-0013-201
CR527	5.1V zener SOT-23	523-2016-519
CR528	5.1V zener SOT-23	523-2016-519
CR529	15V zener SOT-23	523-2016-150
CR530	15V zener SOT-23	523-2016-150
CR531	15V zener SOT-23	523-2016-150
CR532	15V zener SOT-23	523-2016-150
CR533	15V zener SOT-23	523-2016-150
CR534	15V zener SOT-23	523-2016-150

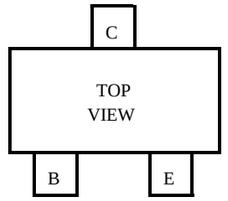
SYMBOL NUMBER	DESCRIPTION	PART NUMBER
CR535	4.3V zener SOT-23	523-2016-439
CR536	15V zener SOT-23	523-2016-150
CR537	15V zener SOT-23	523-2016-150
F 501	1A 250V submin fuse	534-0017-014
FH501	Fuse holder	534-1017-001
HW500	Card inj/ext nylon pull	537-9057-020
J 500	Horizontal green tip jack .080	105-2204-105
J 501	Horizontal black tip jack .080	105-2203-101
J 502	Horizontal red tip jack .080	105-2202-101
J 503	3-pin single inline header	515-7100-003
J 504	3-pin single inline header	515-7100-003
J 505	4-pin single inline header	515-7100-004
K 500	12V SPDT 1A relay submin	567-2002-021
K 501	12V SPDT 1A relay submin	567-2002-021
K 502	12V SPDT 1A relay submin	567-2002-021
K 503	12V SPDT 1A relay submin	567-2002-021
L 501	3 µH filter choke PC mount	542-5007-031
P 500	64-pin DIN male right angle	515-7082-101
P 501	32-pin DIN male right angle	515-7082-102
P 503	2-pos shorting socket	515-5010-001
P 504	2-pos shorting socket	515-5010-001
P 505	2-pos shorting socket	515-5010-001
PC500	PC board	035-2000-350
Q 500	Si NPN SOT-23 2N3904	576-0003-658
Q 501	Si NPN SOT-23 2N3904	576-0003-658
Q 502	Si NPN SOT-23 2N3904	576-0003-658
Q 503	Si NPN SOT-23 2N3904	576-0003-658
Q 504	NPN dig SOT-23F RN1404	576-0003-616
Q 505	NPN dig SOT-23F RN1404	576-0003-616
R 500	4.7k ohm ±5% 1206 SMD	569-0115-472
R 501	4.7k ohm ±5% 1206 SMD	569-0115-472
R 502	430 ohm ±5% 1/4W CF	569-0513-431
R 503	5.1k ohm ±5% 1206 SMD	569-0115-512
R 504	1k ohm ±5% 1206 SMD	569-0115-102
R 505	2k ohm ±5% 1206 SMD	569-0115-202
R 506	1k ohm ±5% 1206 SMD	569-0115-102
R 507	100k ohm ±5% 1206 SMD	569-0115-104
R 508	10k ohm ±1% 1206 SMD	569-0111-401
R 509	10k ohm ±1% 1206 SMD	569-0111-401
R 510	10k ohm ±5% 1206 SMD	569-0115-103
R 511	20k ohm ±5% 1206 SMD	569-0115-203
R 512	10k ohm ±5% 1206 SMD	569-0115-103
R 513	10k ohm ±5% 1206 SMD	569-0115-103
R 514	10k ohm ±5% 1206 SMD	569-0115-103
R 515	1k ohm ±5% 1206 SMD	569-0115-102
R 516	2.7k ohm ±5% 1/4W CF	569-0115-272
R 517	2.7k ohm ±5% 1/4W CF	569-0115-272
R 518	2.7k ohm ±5% 1/4W CF	569-0115-272
R 519	2.7k ohm ±5% 1/4W CF	569-0115-272
R 520	2.7k ohm ±5% 1/4W CF	569-0115-272
R 521	4.7k ohm ±5% 1206 SMD	569-0115-472
R 522	10k ohm ±1% 1206 SMD	569-0111-401
R 523	10k ohm ±1% 1206 SMD	569-0111-401
R 524	4.7k ohm ±5% 1206 SMD	569-0115-472
R 525	10k ohm ±1% 1206 SMD	569-0111-401
R 526	10k ohm ±1% 1206 SMD	569-0111-401
R 527	4.7k ohm ±5% 1206 SMD	569-0115-472
R 528	1.2k ohm ±5% 1206 SMD	569-0115-122
R 529	4.7k ohm ±5% 1206 SMD	569-0115-472
R 530	10k ohm ±1% 1206 SMD	569-0111-401
R 531	4.32k ohm ±1% 1206 SMD	569-0111-362
R 532	4.7k ohm ±5% 1206 SMD	569-0115-472
R 533	1k ohm ±5% 1206 SMD	569-0115-102
R 534	1M ohm ±5% 1206 SMD	569-0115-105
R 535	4.7k ohm ±5% 1206 SMD	569-0115-472
R 536	10k ohm ±5% 1206 SMD	569-0115-103
R 538	100k ohm ±5% 1206 SMD	569-0115-104
R 539	100k ohm ±5% 1206 SMD	569-0115-104
R 540	100k ohm ±5% 1206 SMD	569-0115-104
R 541	200 ohm ±5% 1206 SMD	569-0115-201
R 542	10k ohm ±5% 1206 SMD	569-0115-103
R 543	10k ohm ±5% 1206 SMD	569-0115-103
R 544	1k ohm ±5% 1206 SMD	569-0115-102
R 545	10k ohm ±5% 1206 SMD	569-0115-103
R 546	430 ohm ±5% 1/4W CF	569-0513-431
R 547	430 ohm ±5% 1/4W CF	569-0513-431
R 548	430 ohm ±5% 1/4W CF	569-0513-431
R 549	10k ohm ±5% 1206 SMD	569-0115-103
R 550	10k ohm ±5% 1206 SMD	569-0115-103
R 551	10k ohm ±5% 1206 SMD	569-0115-103
R 552	10k ohm ±5% 1206 SMD	569-0115-103
R 553	1.2k ohm ±5% 1206 SMD	569-0115-122
R 554	1.2k ohm ±5% 1206 SMD	569-0115-122
R 555	1.2k ohm ±5% 1206 SMD	569-0115-122

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
R 556	10k ohm ±5% 1206 SMD	569-0115-103
R 557	10k ohm ±5% 1206 SMD	569-0115-103
R 558	10k ohm ±5% 1206 SMD	569-0115-103
R 559	10k ohm ±5% 1206 SMD	569-0115-103
R 560	10k ohm ±5% 1206 SMD	569-0115-103
R 561	10k ohm ±5% 1206 SMD	569-0115-103
R 562	10k ohm ±5% 1206 SMD	569-0115-103
R 563	3.9k ohm ±5% 1206 SMD	569-0115-392
R 564	1k ohm ±5% 1206 SMD	569-0115-102
R 567	200 ohm ±5% 1206 SMD	569-0115-201
R 568	200 ohm ±5% 1206 SMD	569-0115-201
R 569	200 ohm ±5% 1206 SMD	569-0115-201
R 570	1k ohm ±5% 1206 SMD	569-0115-102
R 571	10k ohm ±5% 1206 SMD	569-0115-103
R 572	16k ohm ±5% 1206 SMD	569-0115-163
R 573	5.1k ohm ±5% 1206 SMD	569-0115-512
R 574	51k ohm ±5% 1206 SMD	569-0115-513
R 575	82k ohm ±5% 1206 SMD	569-0115-823
R 576	2.7k ohm ±5% 1206 SMD	569-0115-272
R 577	1k ohm ±5% 1206 SMD	569-0115-102
R 578	2.7k ohm ±5% 1206 SMD	569-0115-272
S 500	4-pos recessed DIP switch	583-5002-104
S 501	4-pos recessed DIP switch	583-5002-104
S 502	4-pos recessed DIP switch	583-5002-104
S 503	4-pos recessed DIP switch	583-5002-104
S 508	Toggle switch on/on rt angle	583-0006-014

SYMBOL NUMBER	DESCRIPTION	PART NUMBER
U 500	1 of 16 demux SOIC 74HC154	544-3766-154
U 501	1 of 16 demux SOIC 74HC154	544-3766-154
U 503	D flip flop SOIC 74HC574	544-3766-574
U 504	D flip flop SOIC 74HC574	544-3766-574
U 505	D flip flop SOIC 74HC574	544-3766-574
U 506	8-bit A/D converter	544-2031-001
U 507	Bilateral switch SOIC 4066B	544-3016-066
U 508	Hex open drain buffer SO-14	544-3716-906
U 509	Quad op amp SOIC	544-2020-008
U 510	NPN out opto isolator 4N35	544-2010-001
U 511	NPN out opto isolator 4N35	544-2010-001
U 512	NPN out opto isolator 4N35	544-2010-001
U 513	Bilateral switch SOIC 4066B	544-3016-066
U 514	Dual op amp SOIC LM2904	544-2019-004
U 515	NPN out opto isolator 4N35	544-2010-001
U 516	NPN out opto isolator 4N35	544-2010-001
U 517	Transparent latch SOIC	544-3766-573
U 518	D flip flop SOIC 74HC574	544-3766-574
U 519	Low pwr FM IF SO-16	544-2026-008
U 520	NPN out opto isolator 4N35	544-2010-001
U 521	Transparent latch SOIC	544-3766-573
U 522	+12V regulator TO-92 78L12	544-2003-032
U 523	+8V regulator 78M08	544-2003-081
Z 500	EMI suppression filter	532-3003-002
Z 501	EMI suppression filter	532-3003-002

SECTION 10 SCHEMATICS AND COMPONENT LAYOUTS

TRANSISTORS		
PART NUMBER	BASING NUMBER	IDENTIFICATION
576-0001-300	1	1R
576-0002-603	2	
576-0003-600	1	2X
576-0003-602	1	R2/R3
576-0003-604	3	3604
576-0003-612	1	2T
576-0003-636	1	R25
576-0003-657	1	2A
576-0003-658	1	1A
576-0004-098	3	
576-0004-820	4	
576-0004-821	4	
576-0006-109	5	
DIODES		
523-1504-002	6	5A
523-1504-012	6	2A
523-1504-015	6	4E
523-1504-016	6	5H
523-1504-023	-	A7
523-2016-180	6	Y7
523-2016-479	6	8E/Z1
523-2016-519	6	8F/Z2
523-2016-629	6	8J/Z4
523-2016-919	6	8P/Z8
523-5004-002		



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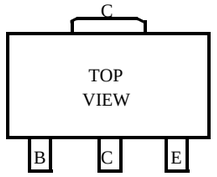

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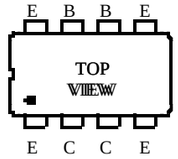

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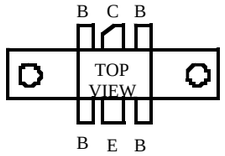

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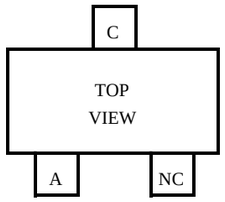
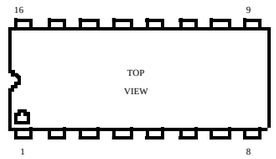
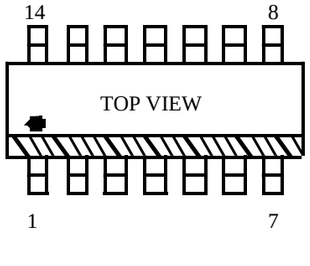
5

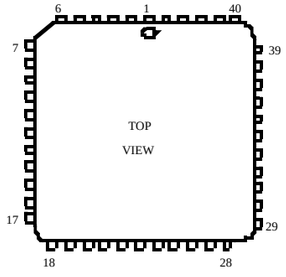


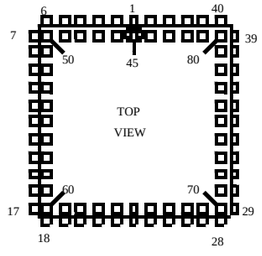
6

INTEGRATED CIRCUITS









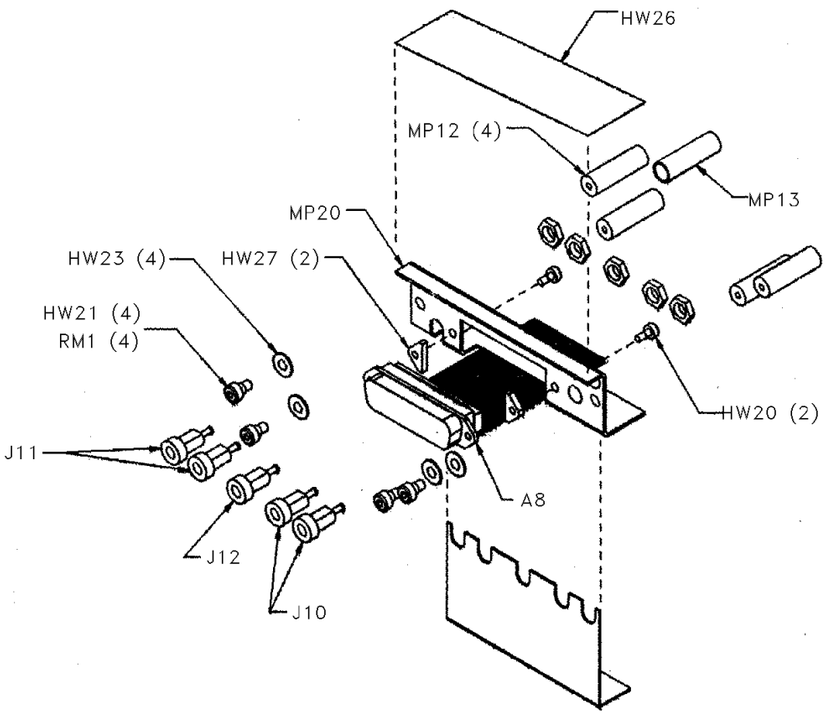


FIGURE 10-1 RF MODULE INTERFACE CONNECTOR

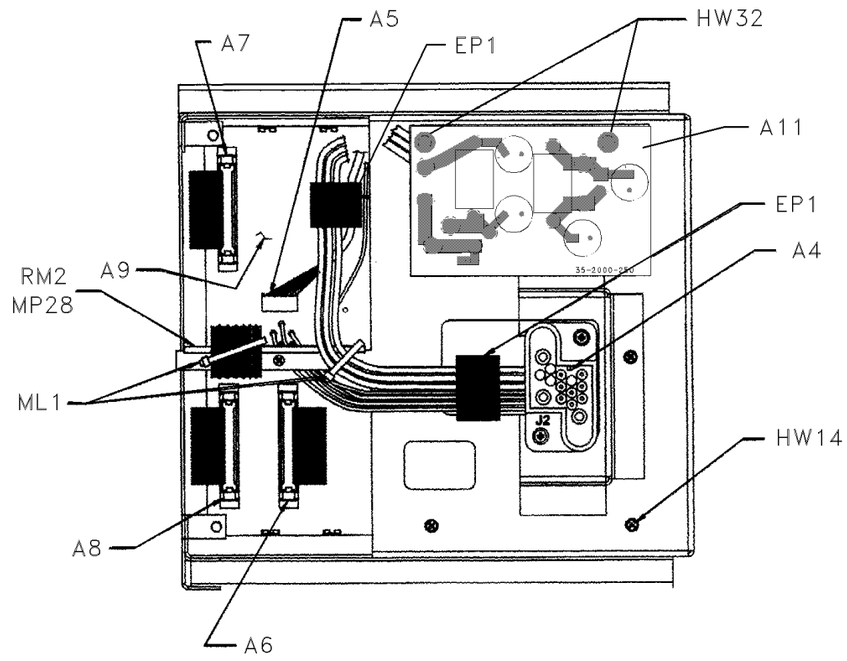
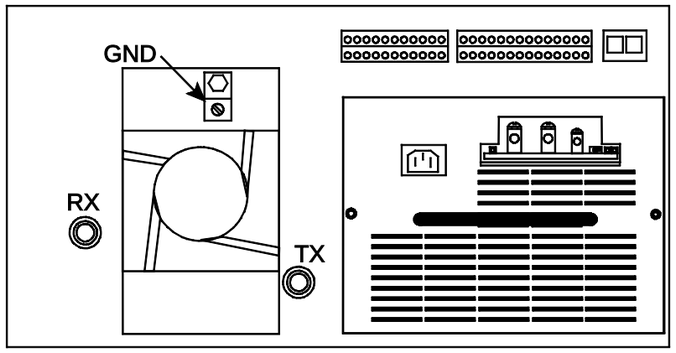
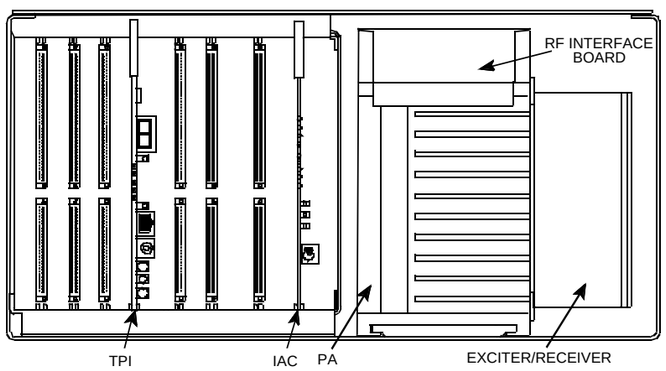


FIGURE 10-2 BACKPLANE CABLE CONNECITONS

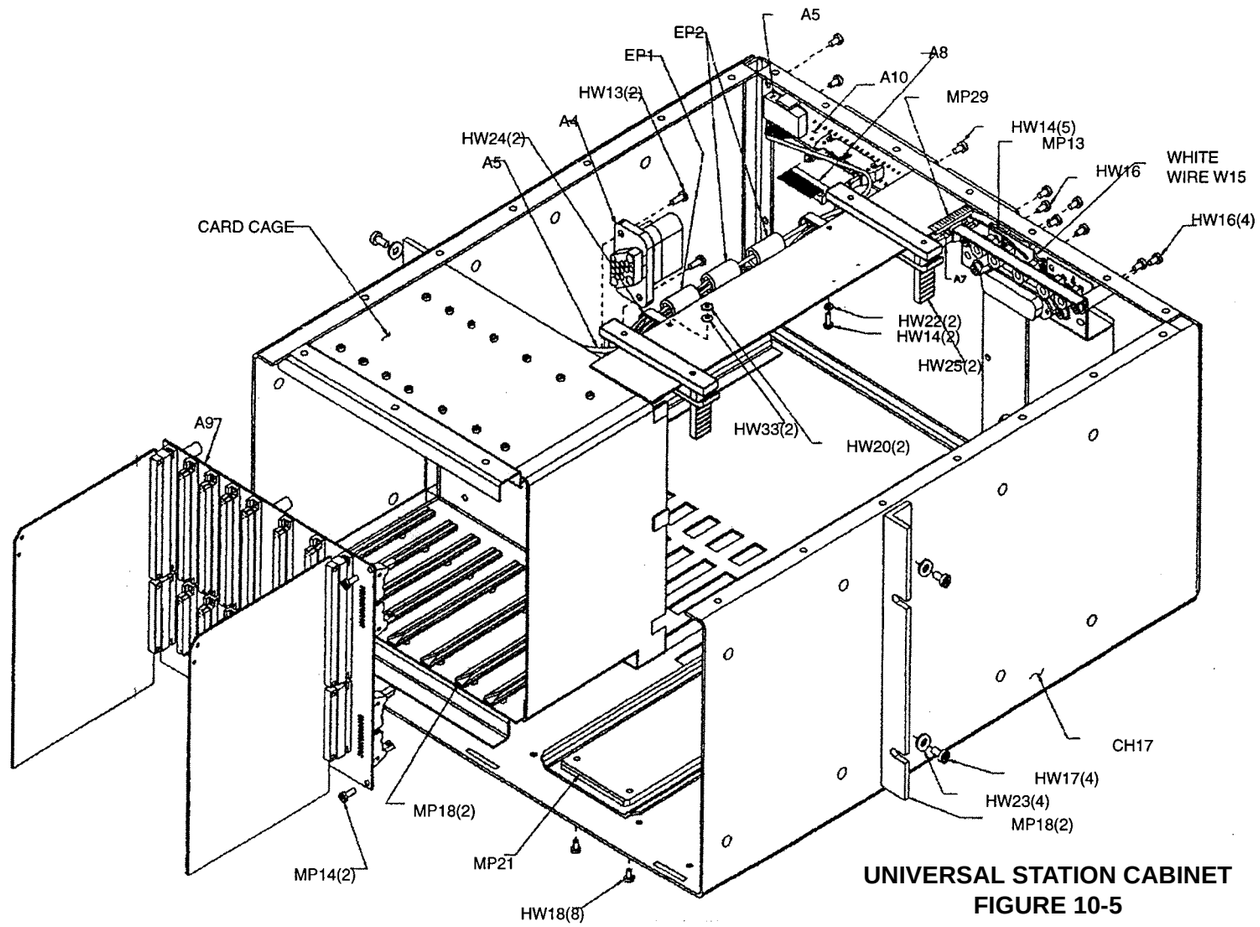
FOLDOUT →



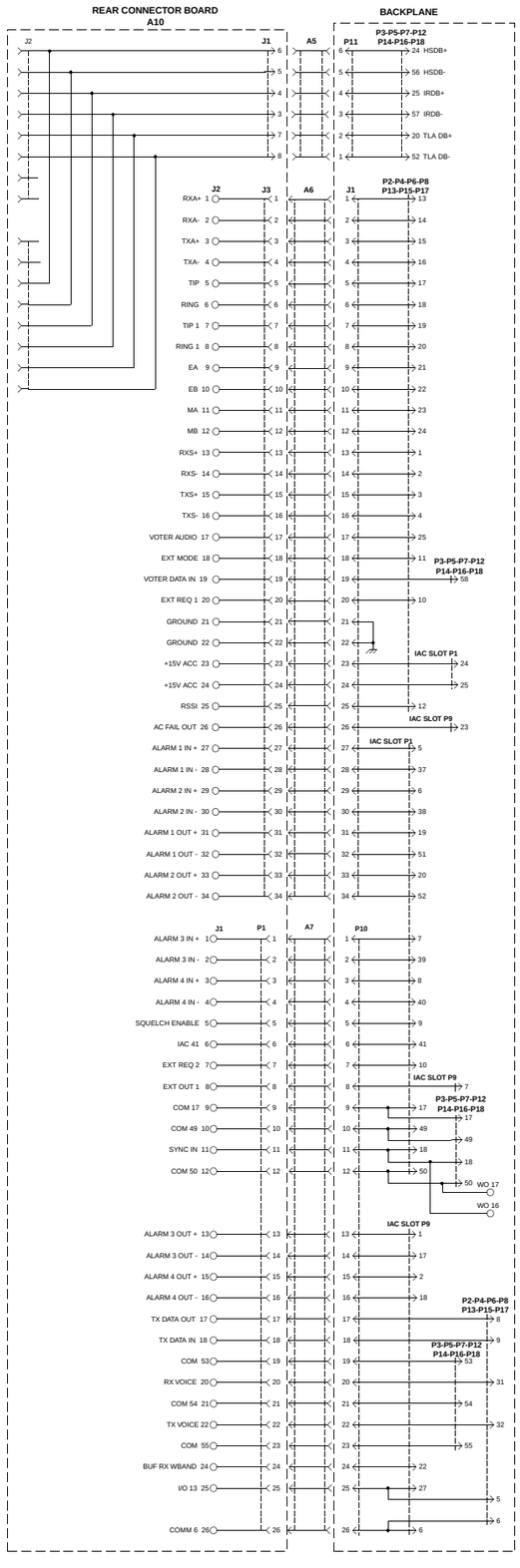
UNIVERSAL STATION REAR VIEW
FIGURE 10-3



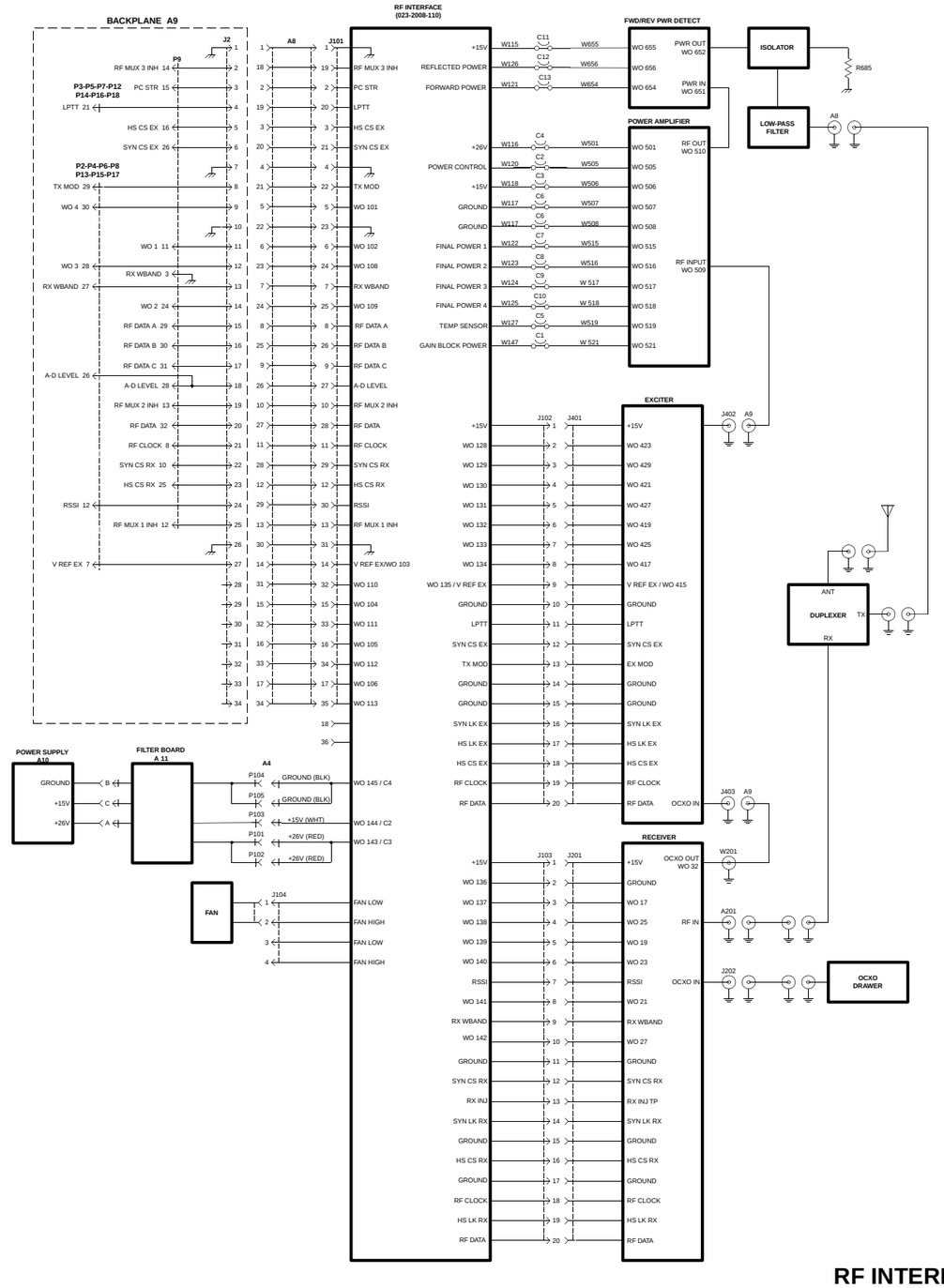
UNIVERSAL STATION FRONT VIEW
FIGURE 10-4



UNIVERSAL STATION CABINET
FIGURE 10-5

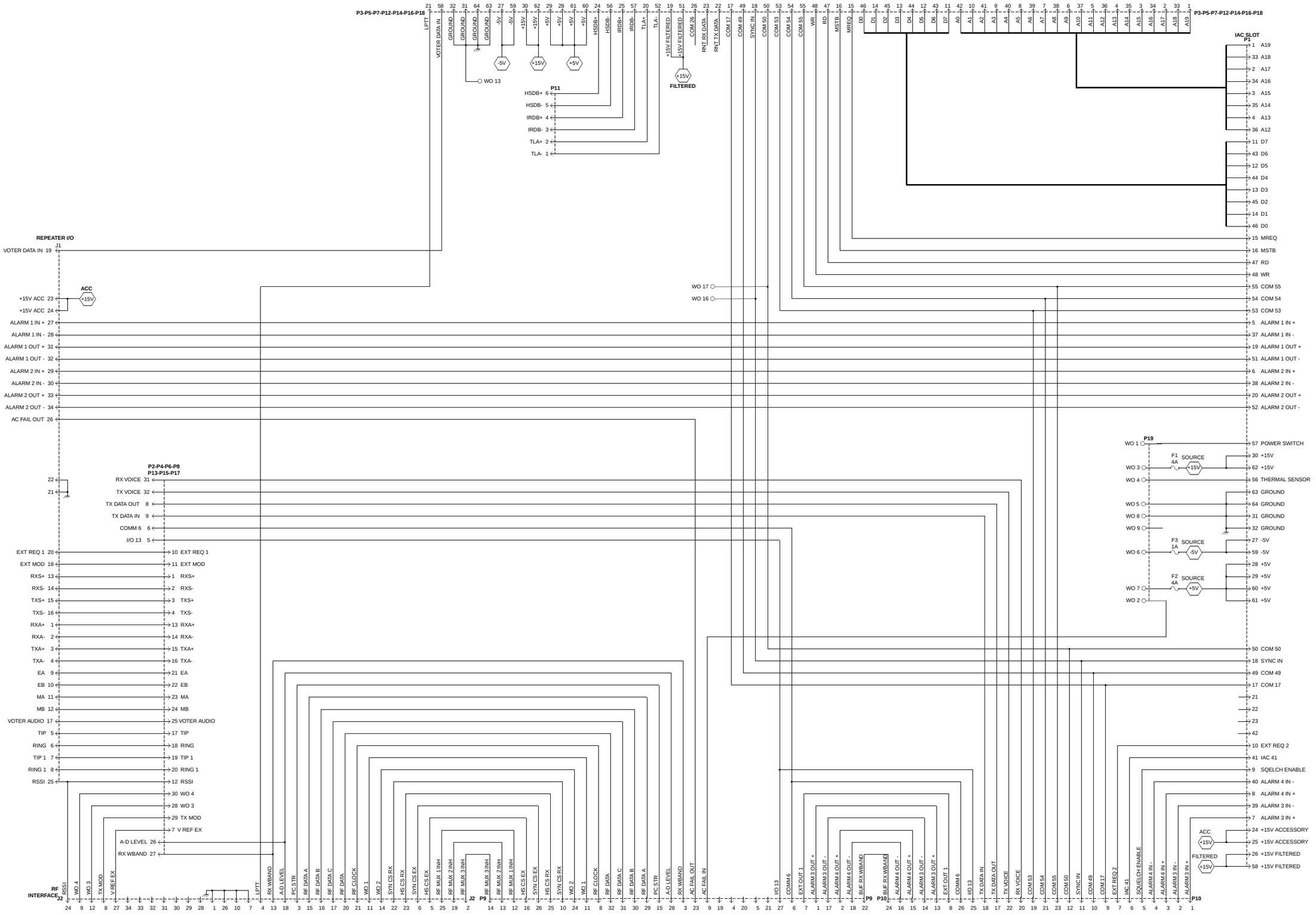


INPUT/OUTPUT ALARM INTERFACE
FIGURE 10-6

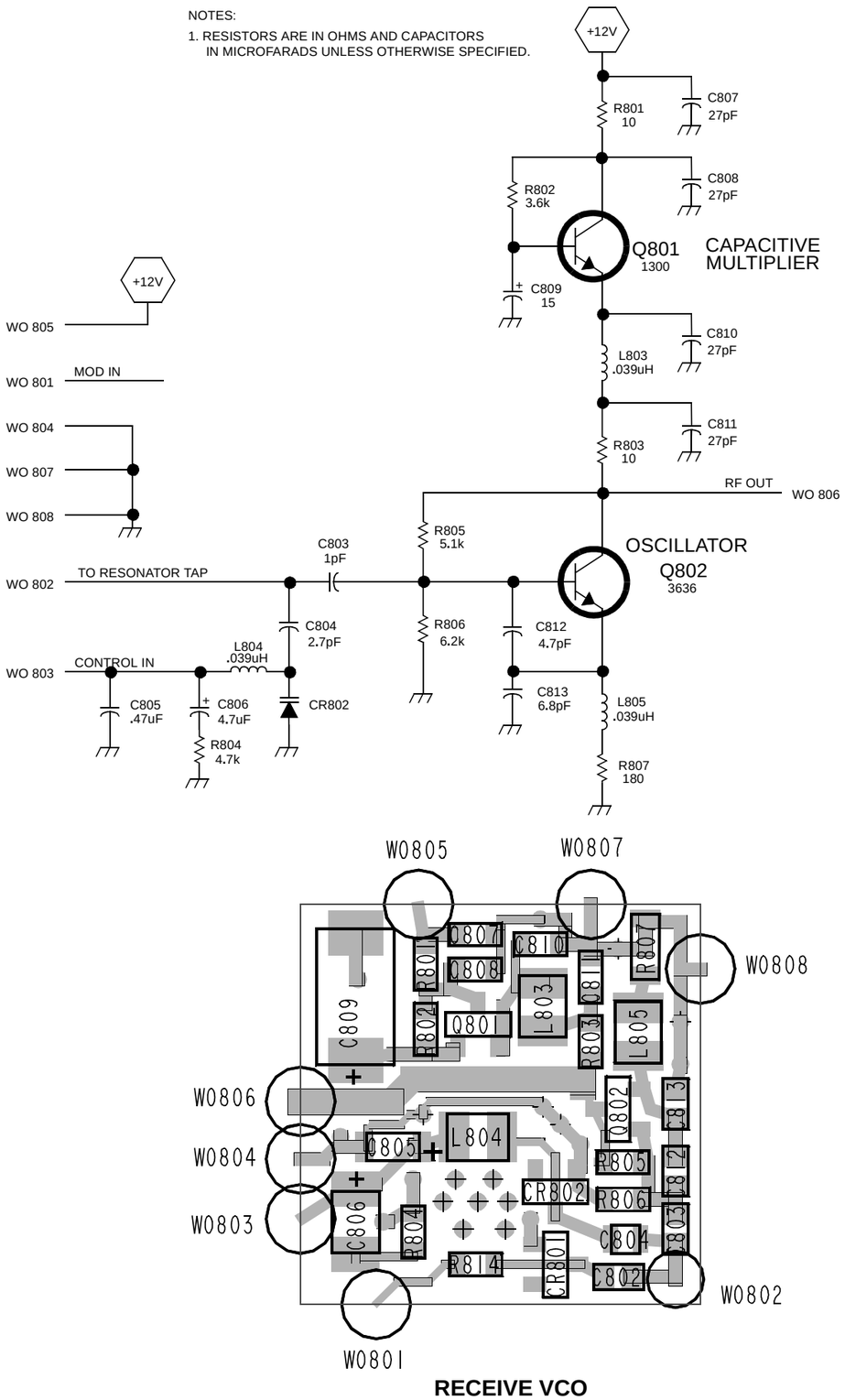


RF INTERFACE
FIGURE 10-7

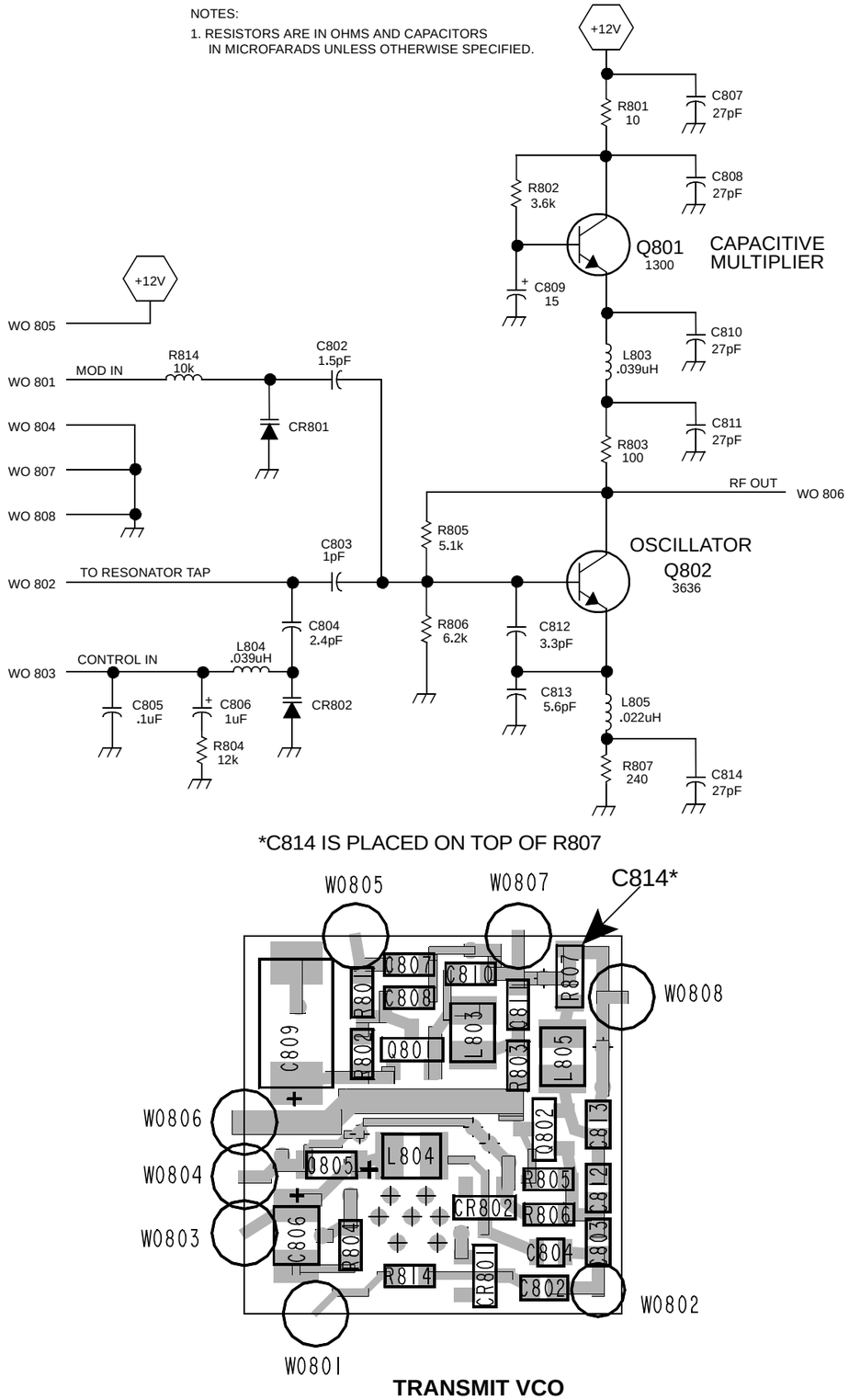
FOLDOUT



BACKPLANE INTERCONNECT
FIGURE 10-8



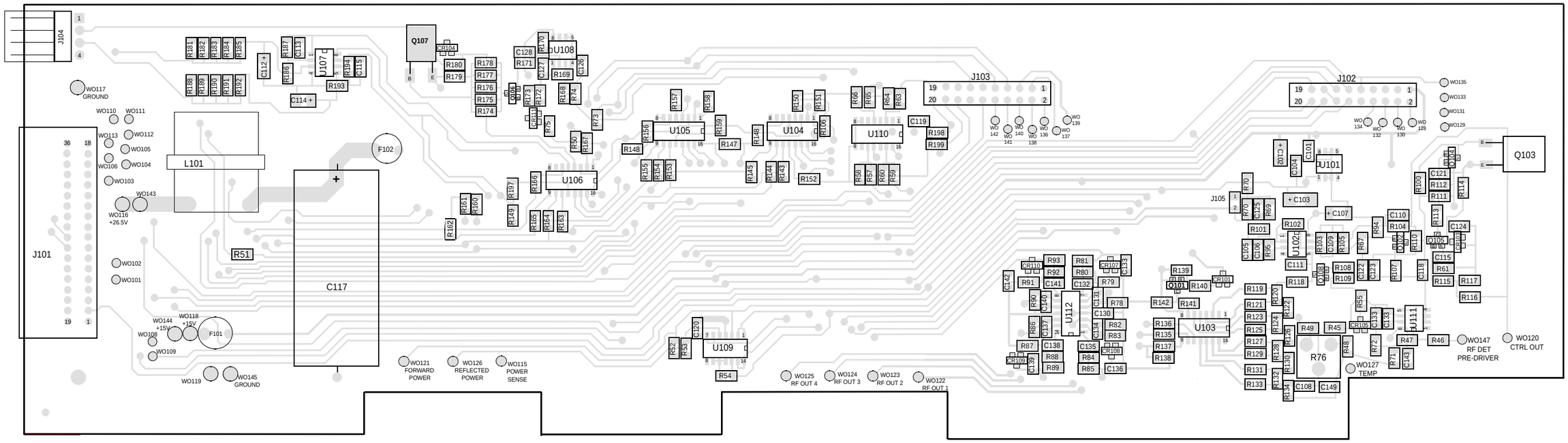
RECEIVE VCO
FIGURE 10-9



TRANSMIT VCO
FIGURE 10-10

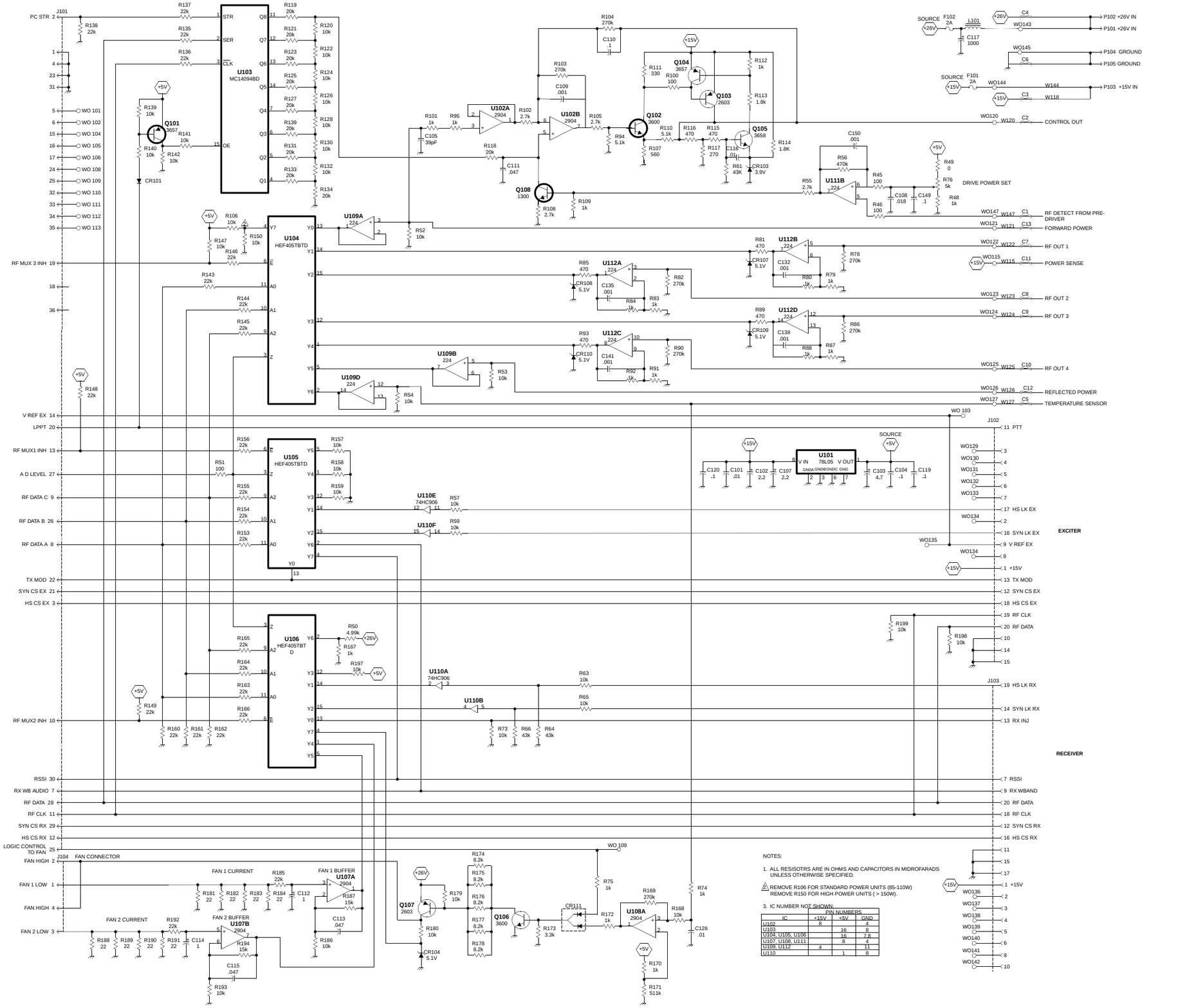
Month 2000
Part No. 001-2008-104

FOLDOUT



Month 2000
Part No. 001-2008-104

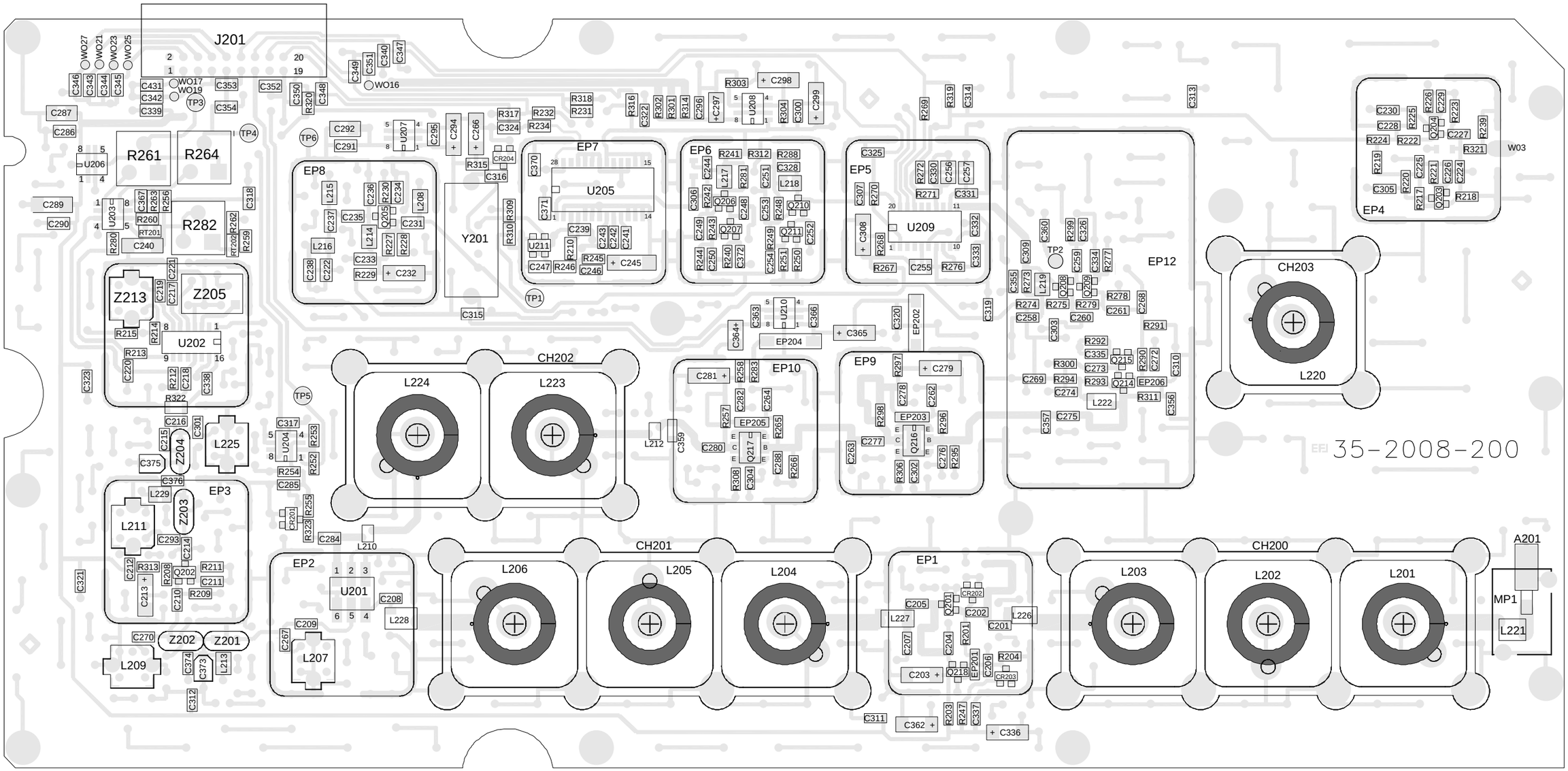
RF INTERFACE BOARD COMPONENT LAYOUT
FIGURE 10-11



Month 2000
Part No. 001-2008-104

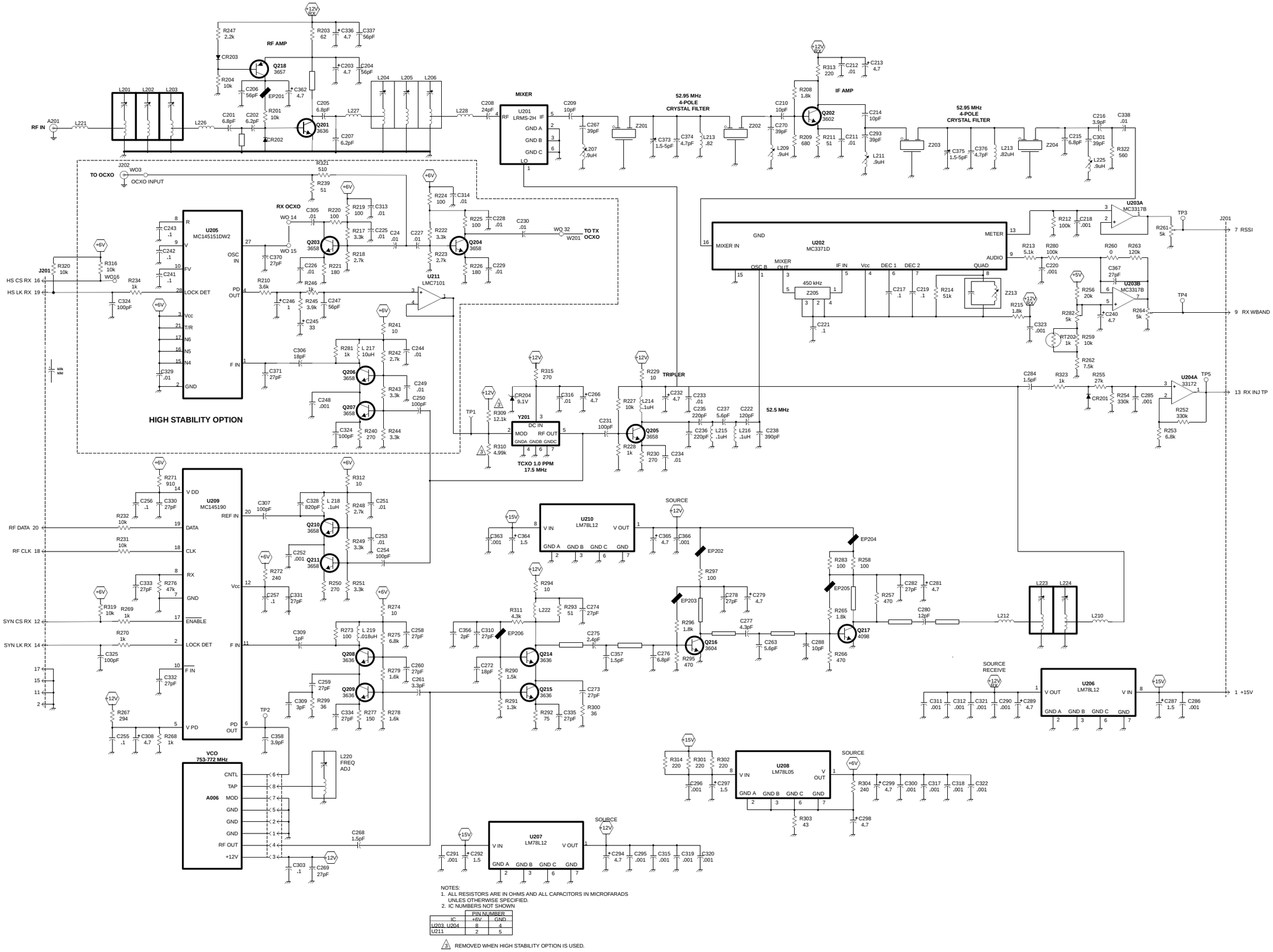
RF INTERFACE BOARD SCHEMATIC
FIGURE 10-12

FOLDOUT



Month 2000
Part No. 001-2008-104

RECEIVER COMPONENT LAYOUT
FIGURE 10-13



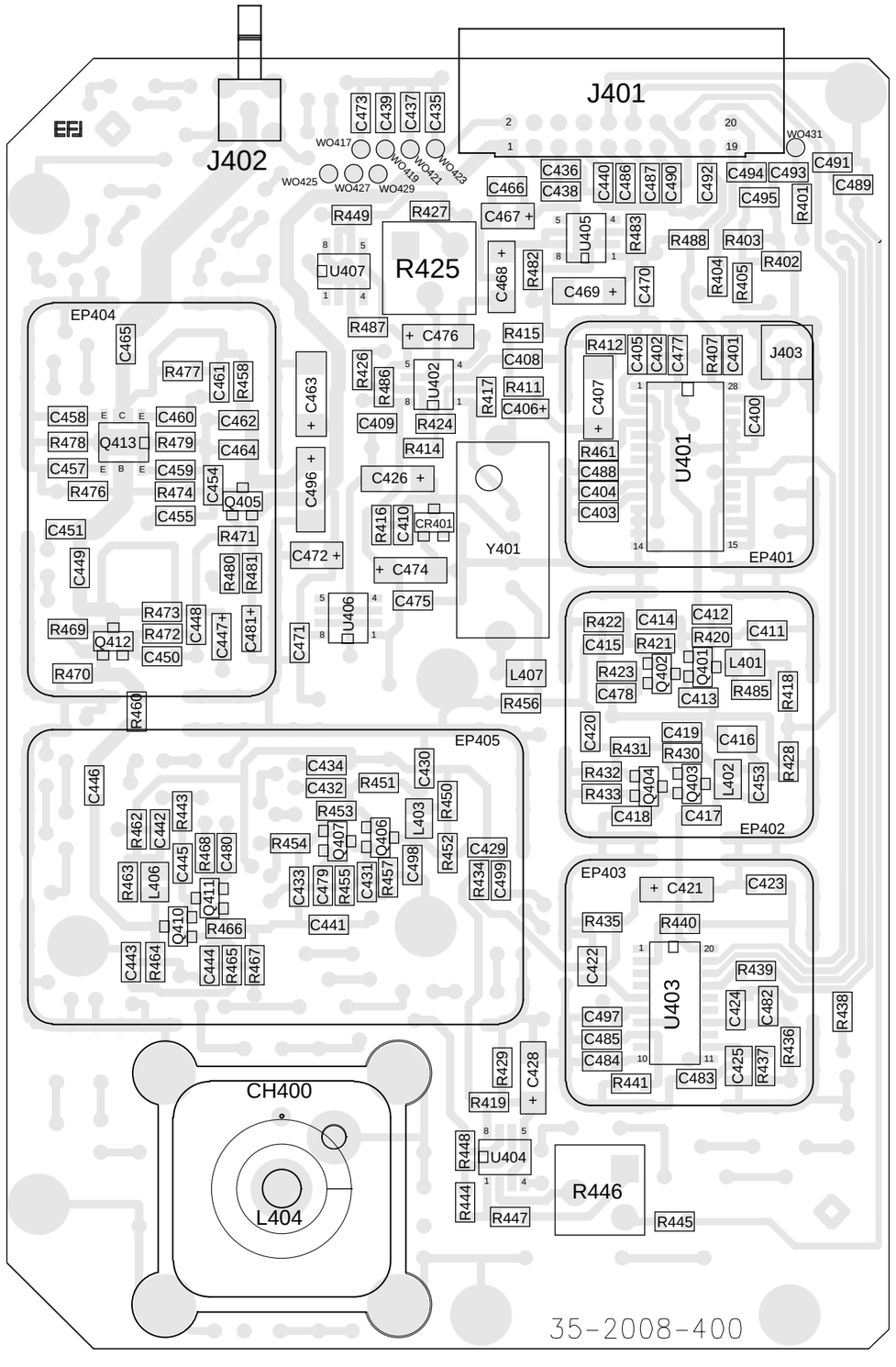
NOTES:
1. ALL RESISTORS ARE IN OHMS AND ALL CAPACITORS IN MICROFARADS UNLESS OTHERWISE SPECIFIED.
2. IC NUMBERS NOT SHOWN

IC	PIN NUMBER +6V	PIN NUMBER GND
U203, U204	8	4
U211	2	5

3 REMOVED WHEN HIGH STABILITY OPTION IS USED.

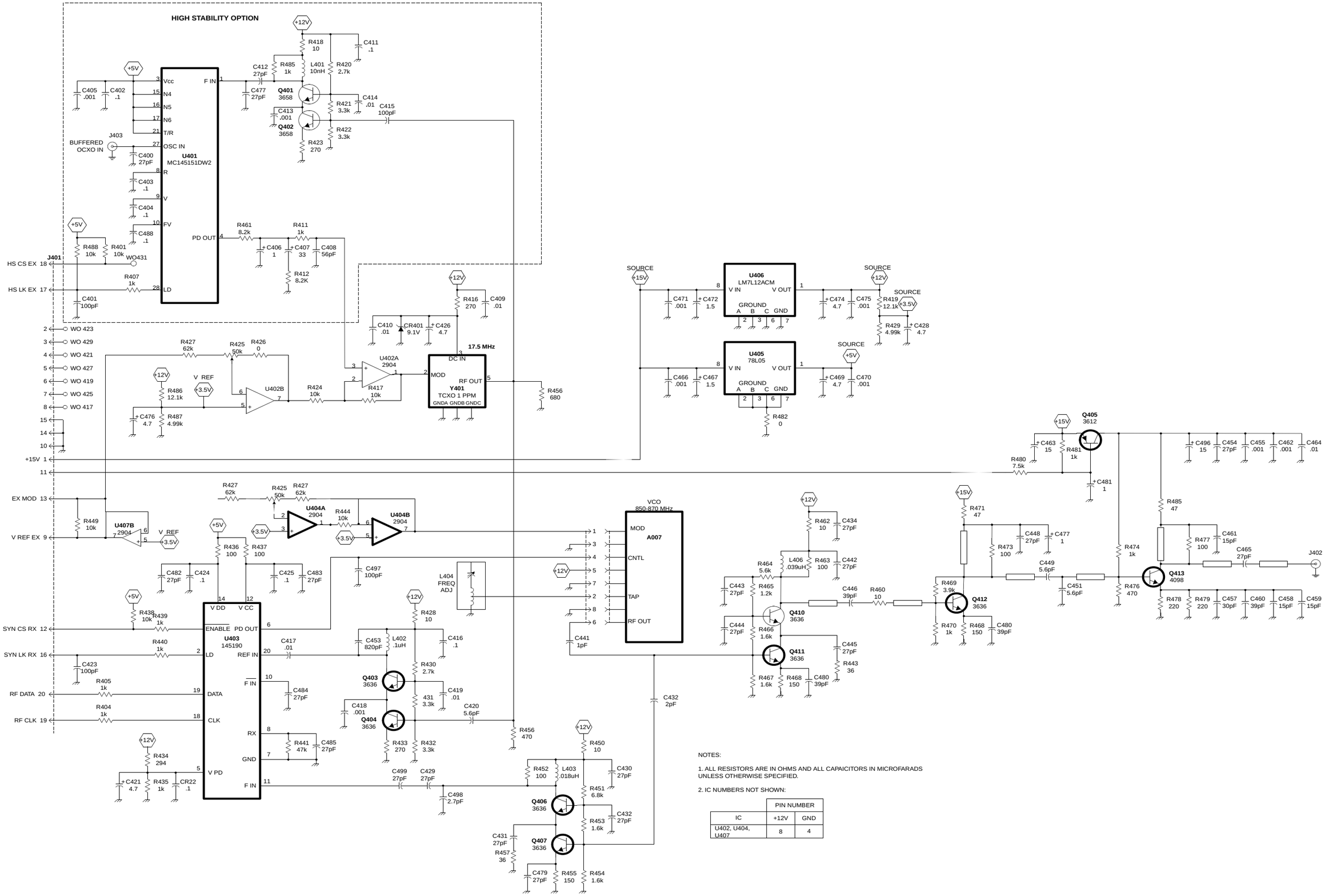
RECEIVER SCHEMATIC
FIGURE 10-14

FOLDOUT



EXCITER COMPONENT LAYOUT
FIGURE 10-15

Month 2000
Part No. 001-2008-104



NOTES:

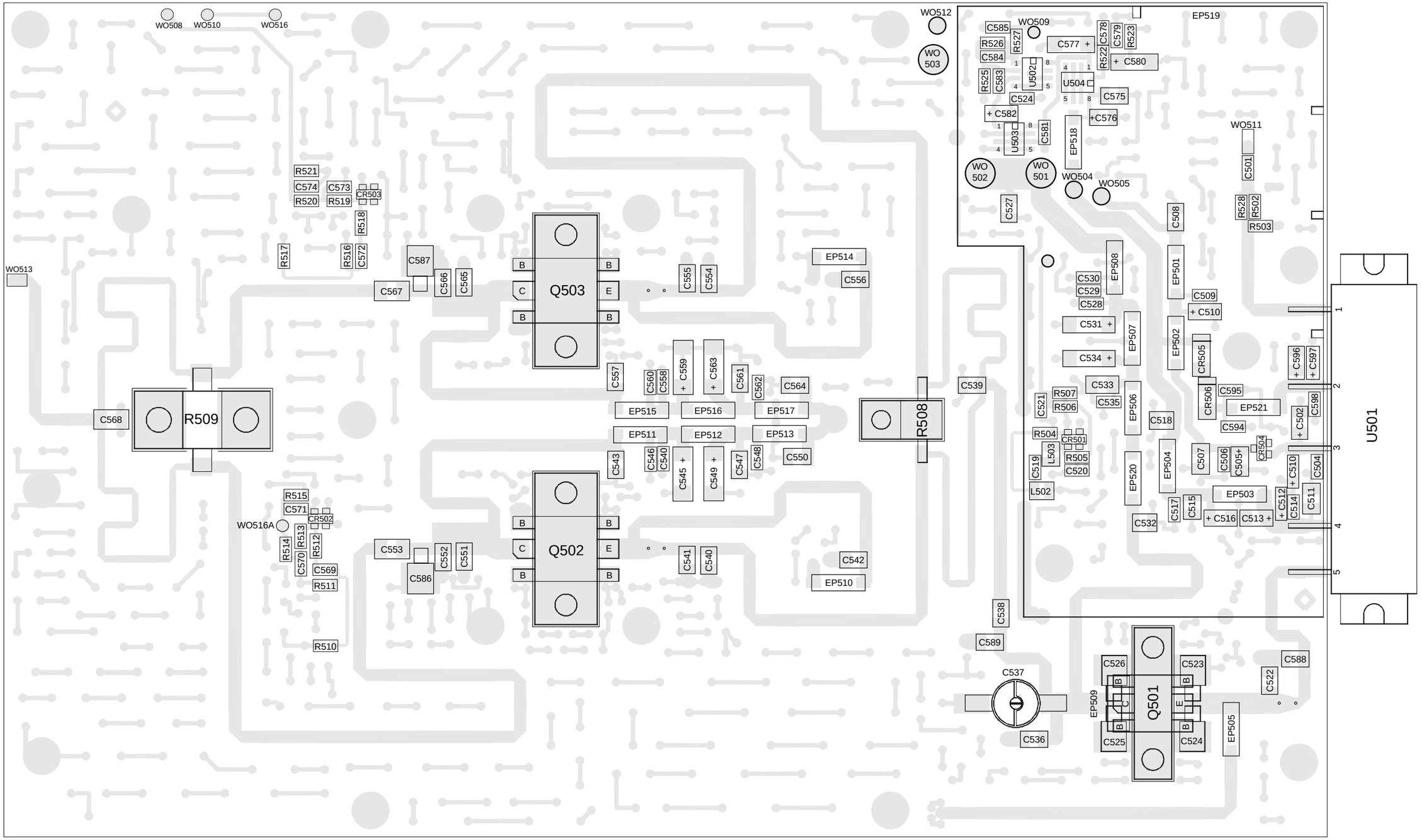
1. ALL RESISTORS ARE IN OHMS AND ALL CAPACITORS IN MICROFARADS UNLESS OTHERWISE SPECIFIED.

2. IC NUMBERS NOT SHOWN:

IC	PIN NUMBER	
	+12V	GND
U402, U404, U407	8	4

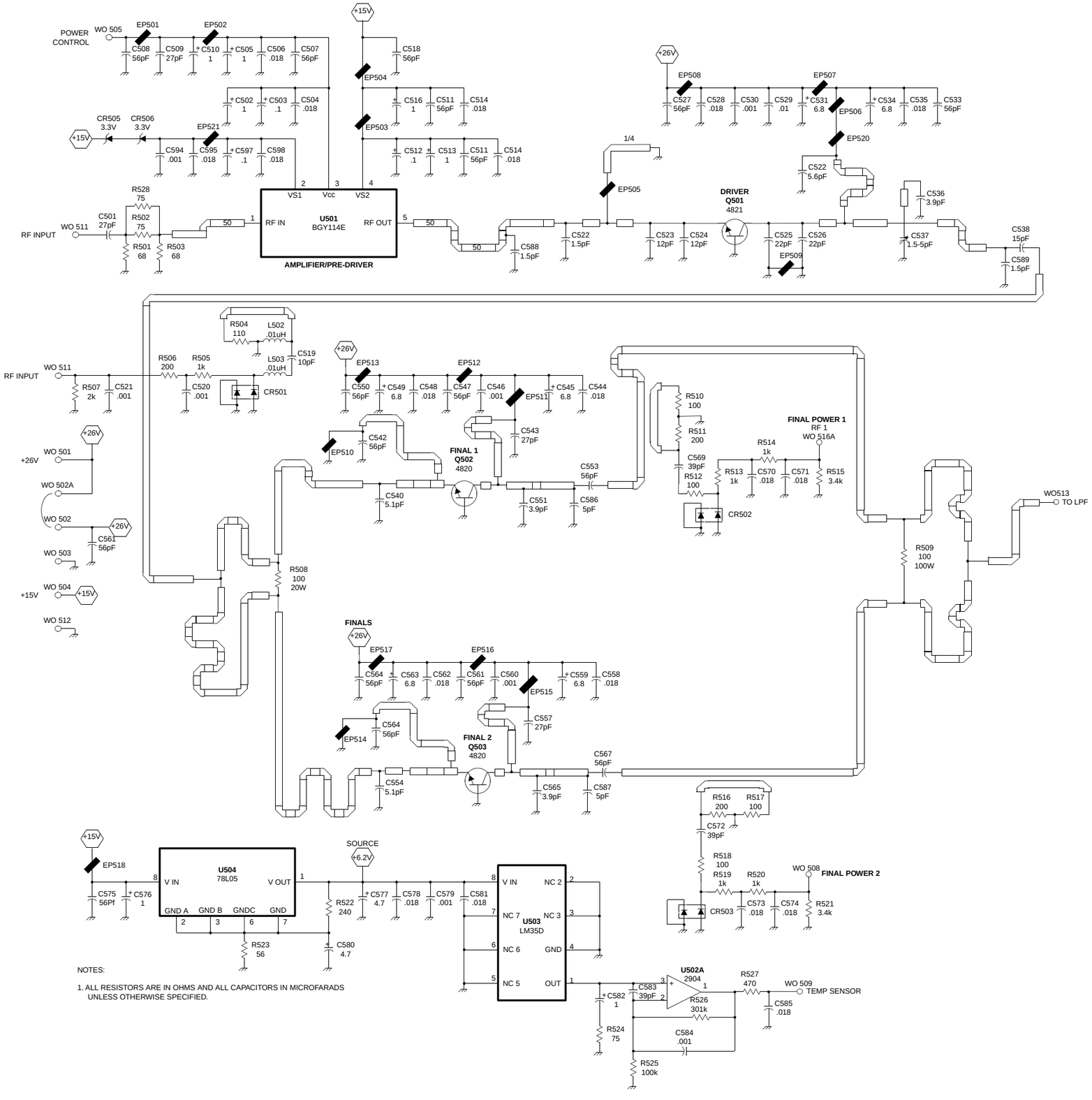
EXCITER SCHEMATIC
FIGURE 10-16

FOLDOUT



Month 2000
Part No. 001-2008-104

75W POWER AMPLIFIER COMPONENT LAYOUT
FIGURE 10-17

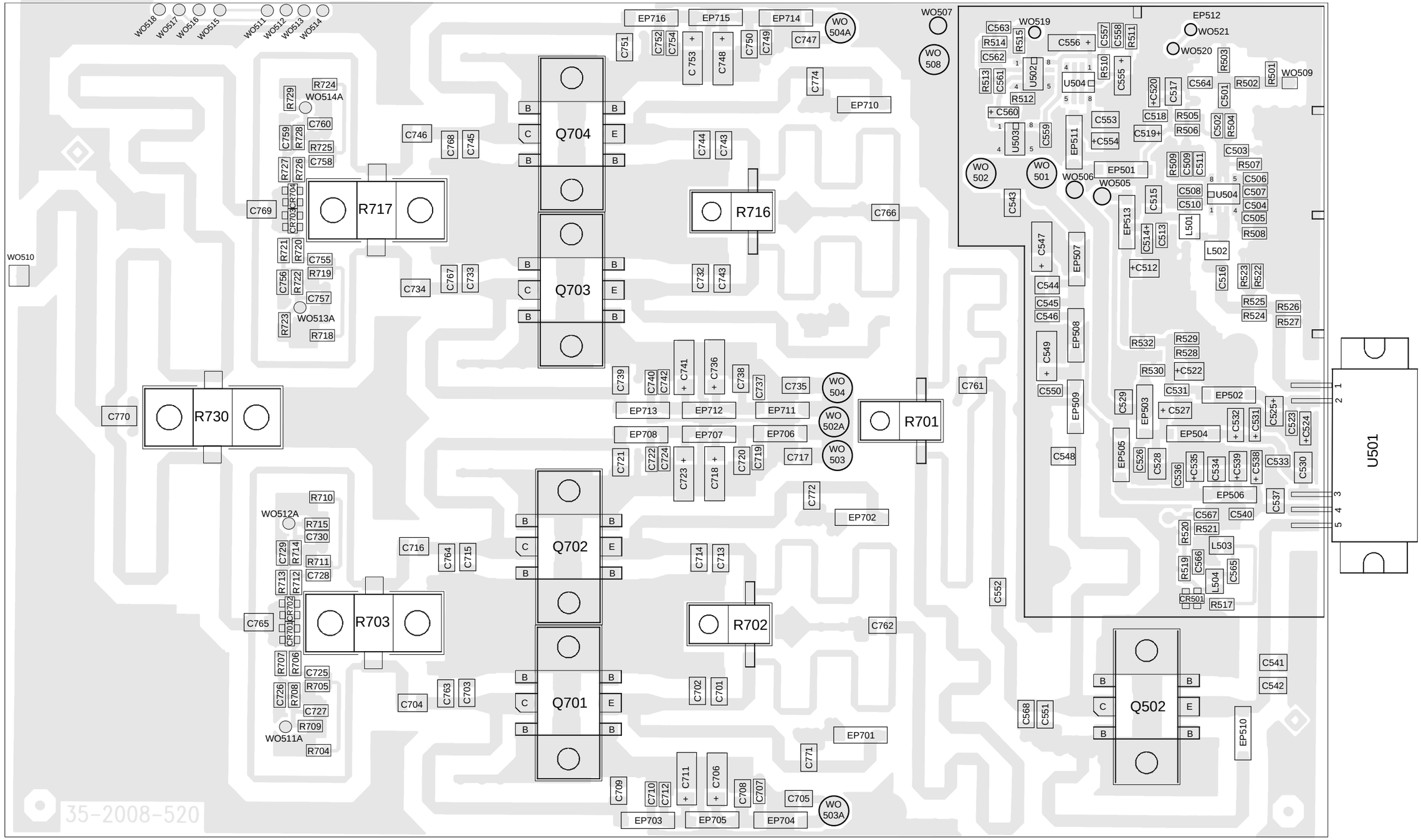


NOTES:

1. ALL RESISTORS ARE IN OHMS AND ALL CAPACITORS IN MICROFARADS UNLESS OTHERWISE SPECIFIED.

75W POWER AMPLIFIER SCHEMATIC
FIGURE 10-18

FOLDOUT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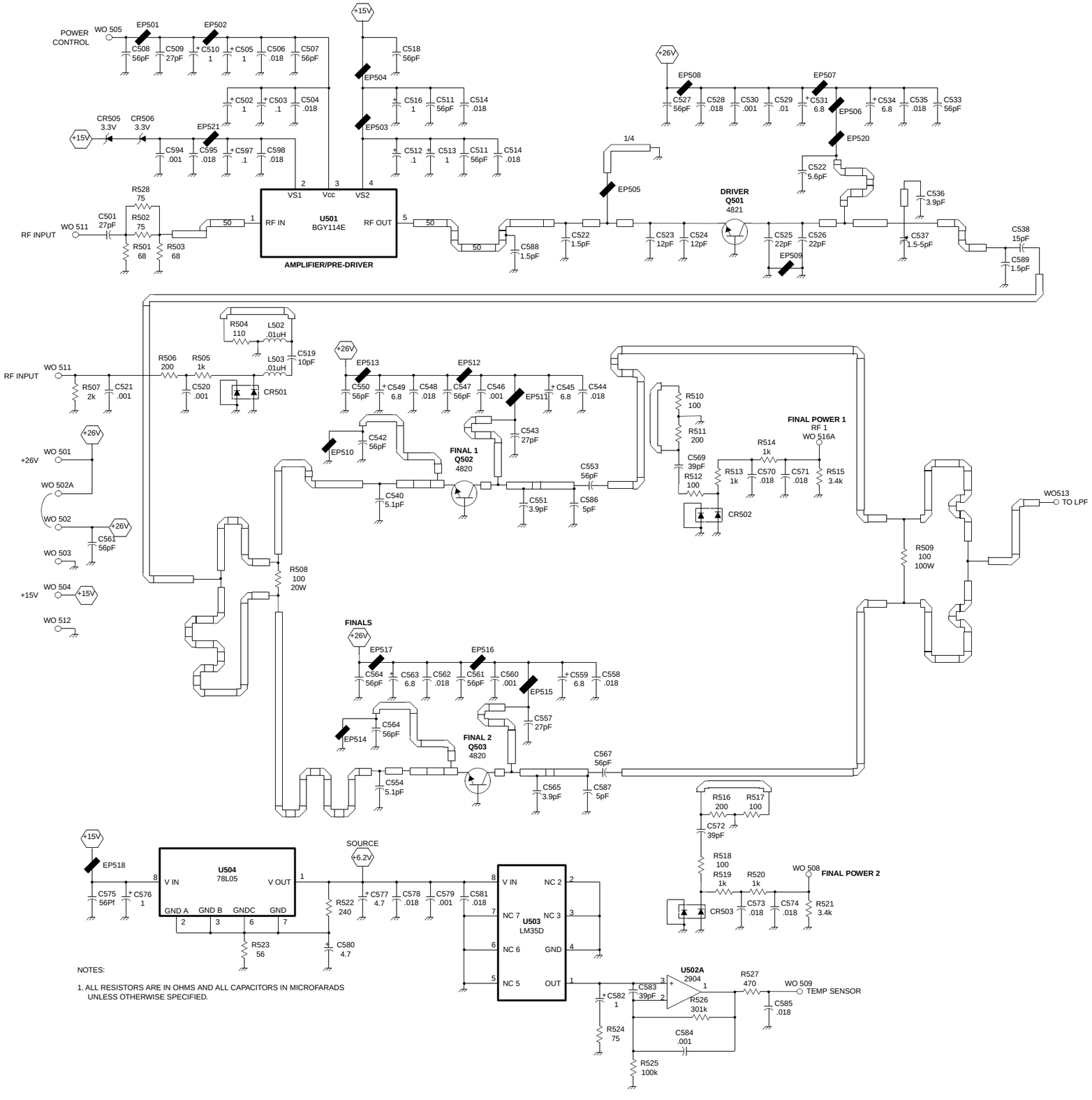
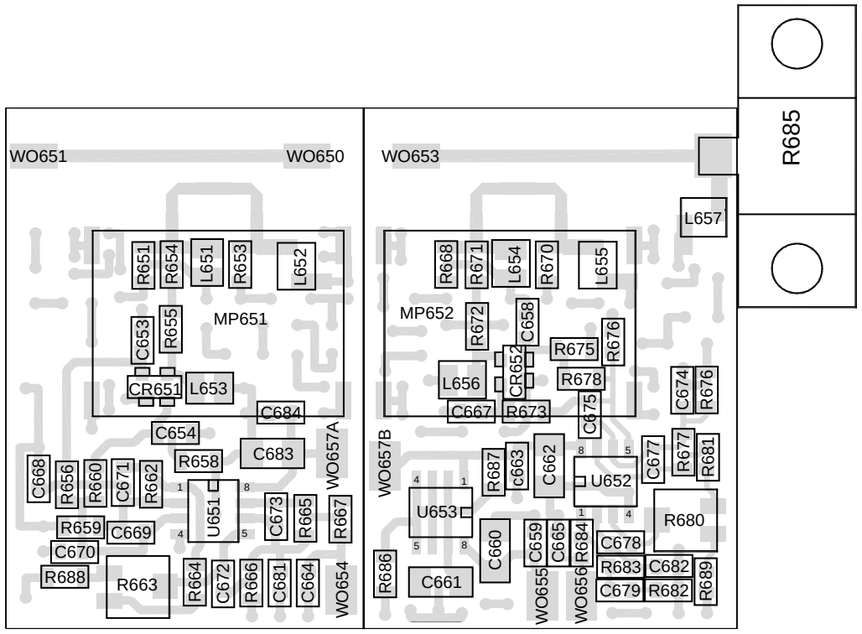


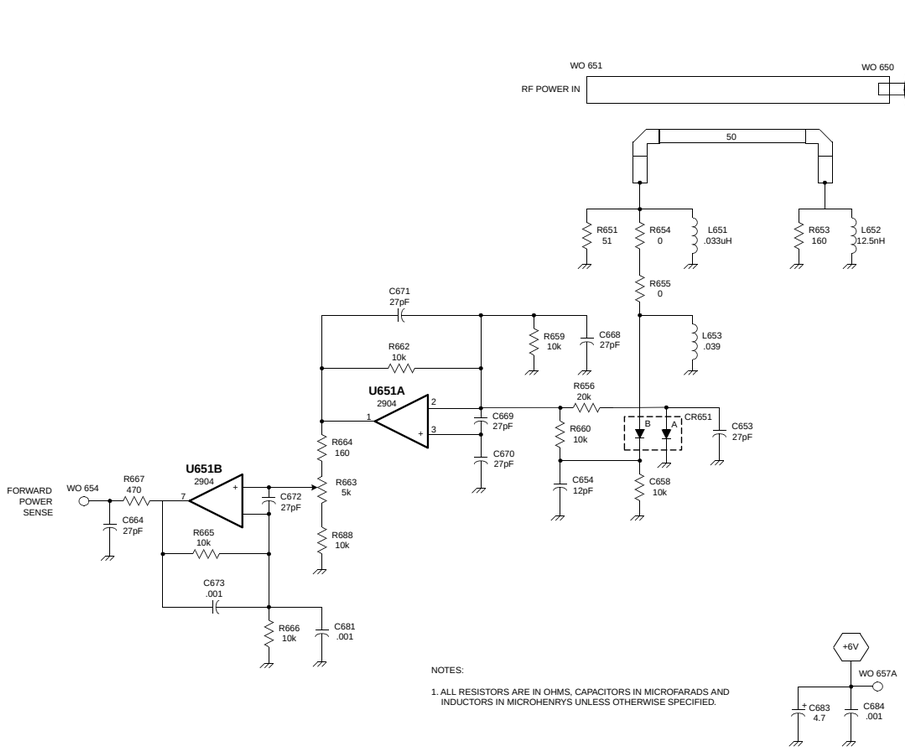
NOTES:

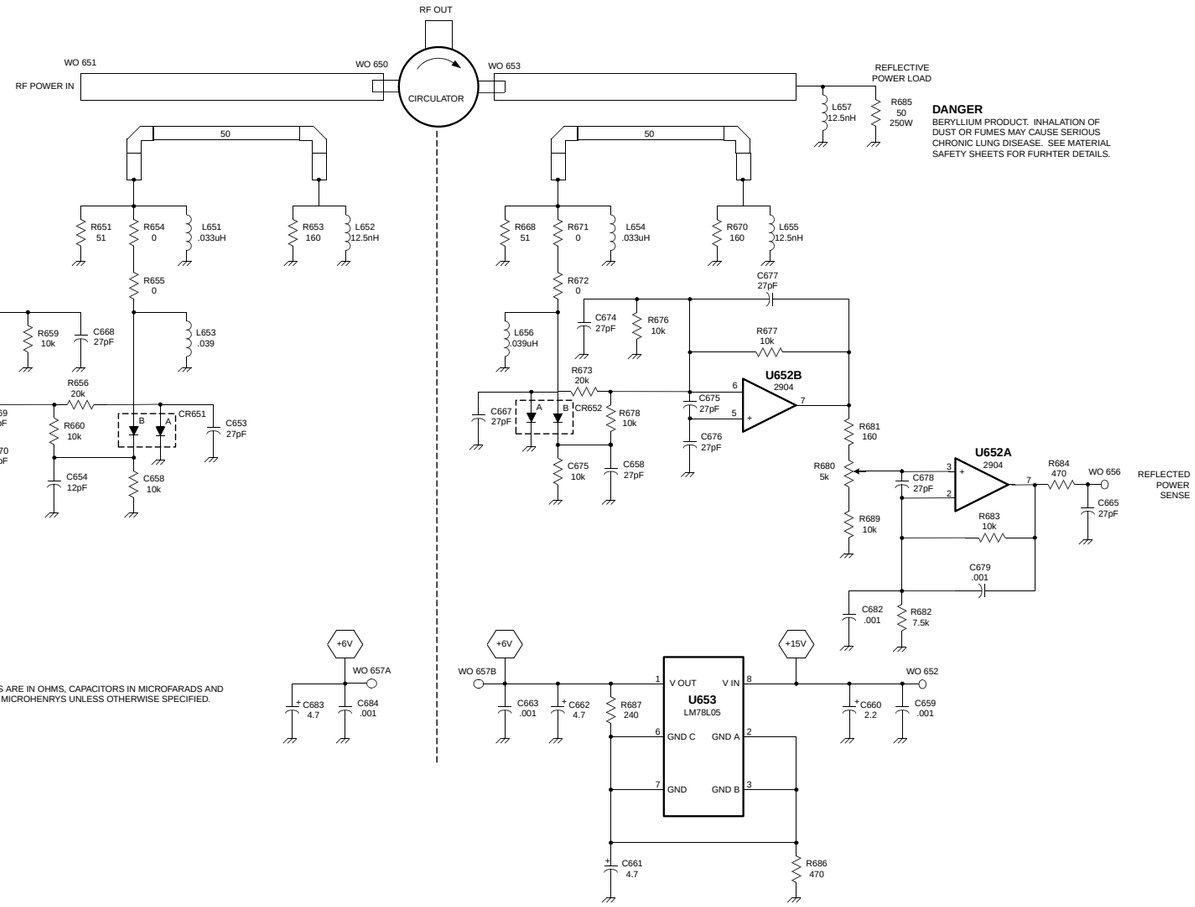
1. ALL RESISTORS ARE IN OHMS AND ALL CAPACITORS IN MICROFARADS UNLESS OTHERWISE SPECIFIED.

175W POWER AMPLIFIER SCHEMATIC
FIGURE 10-20

FOLDOUT

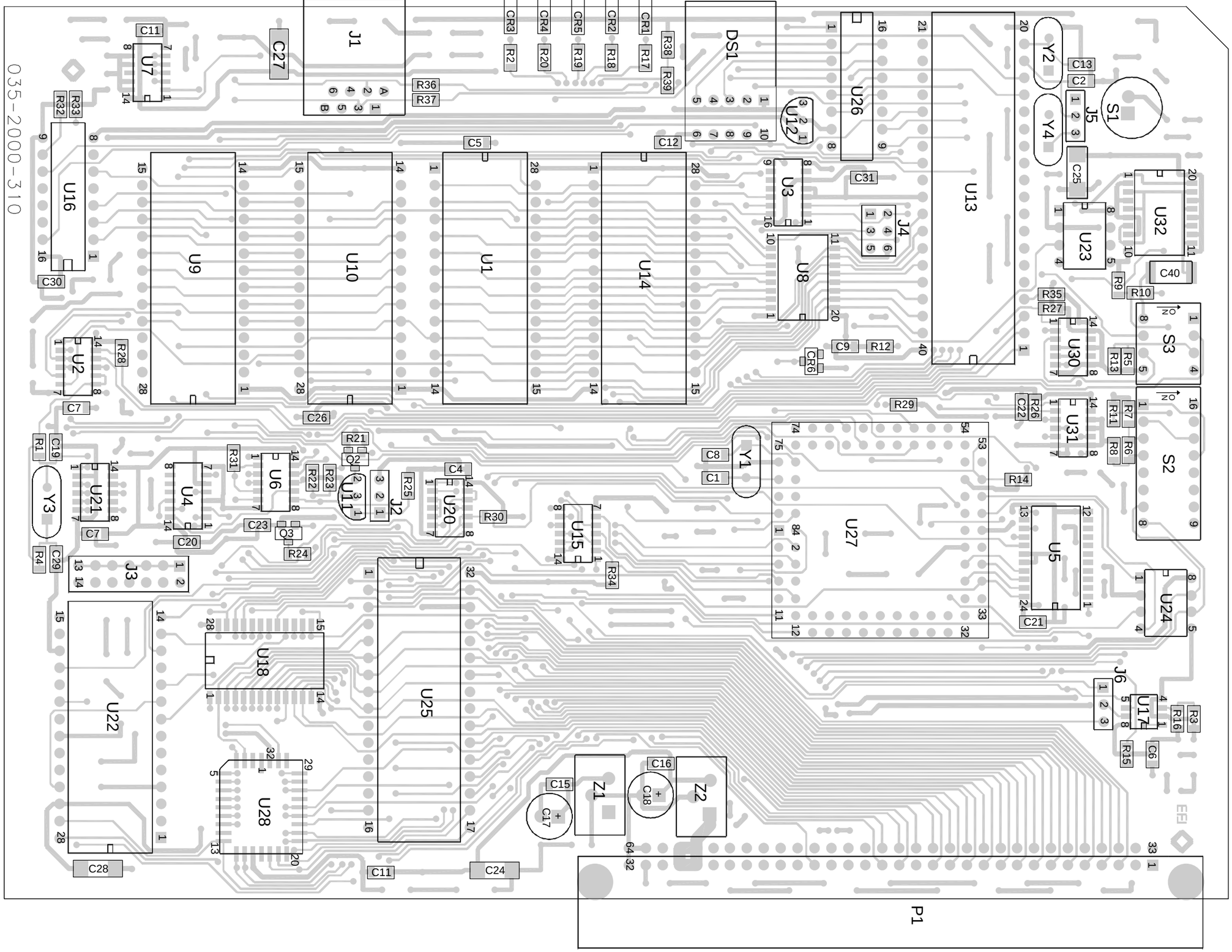






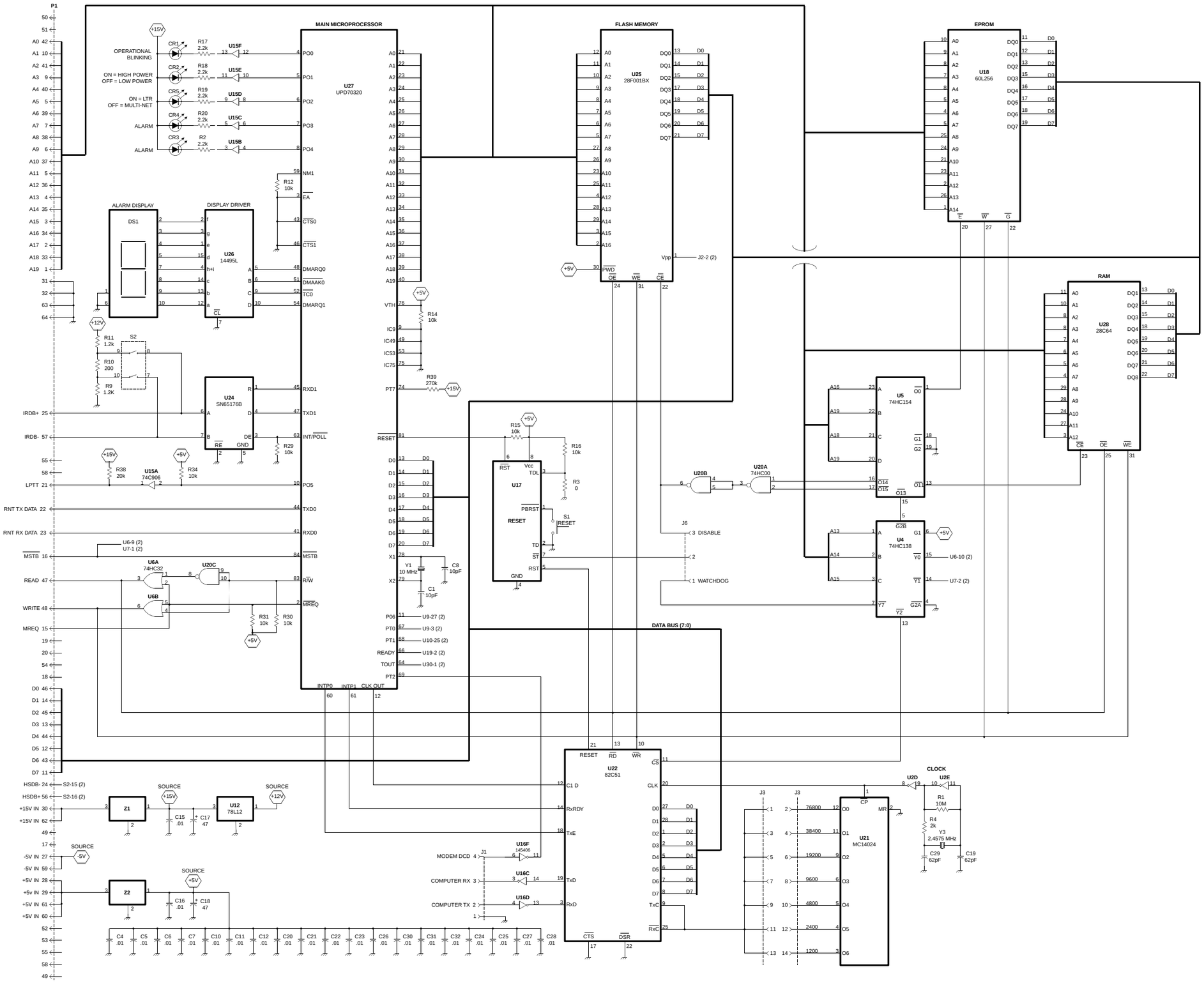
DANGER
BERYLLIUM PRODUCT. INHALATION OF DUST OR FUMES MAY CAUSE SERIOUS CHRONIC LUNG DISEASE. SEE MATERIAL SAFETY SHEETS FOR FURHTER DETAILS.

FORWARD/REVERSE POWER BOARD
FIGURE 10-21



MAIN PROCESSOR CARD COMPONENT LAYOUT)
FIGURE 10-22

FOLDOUT →



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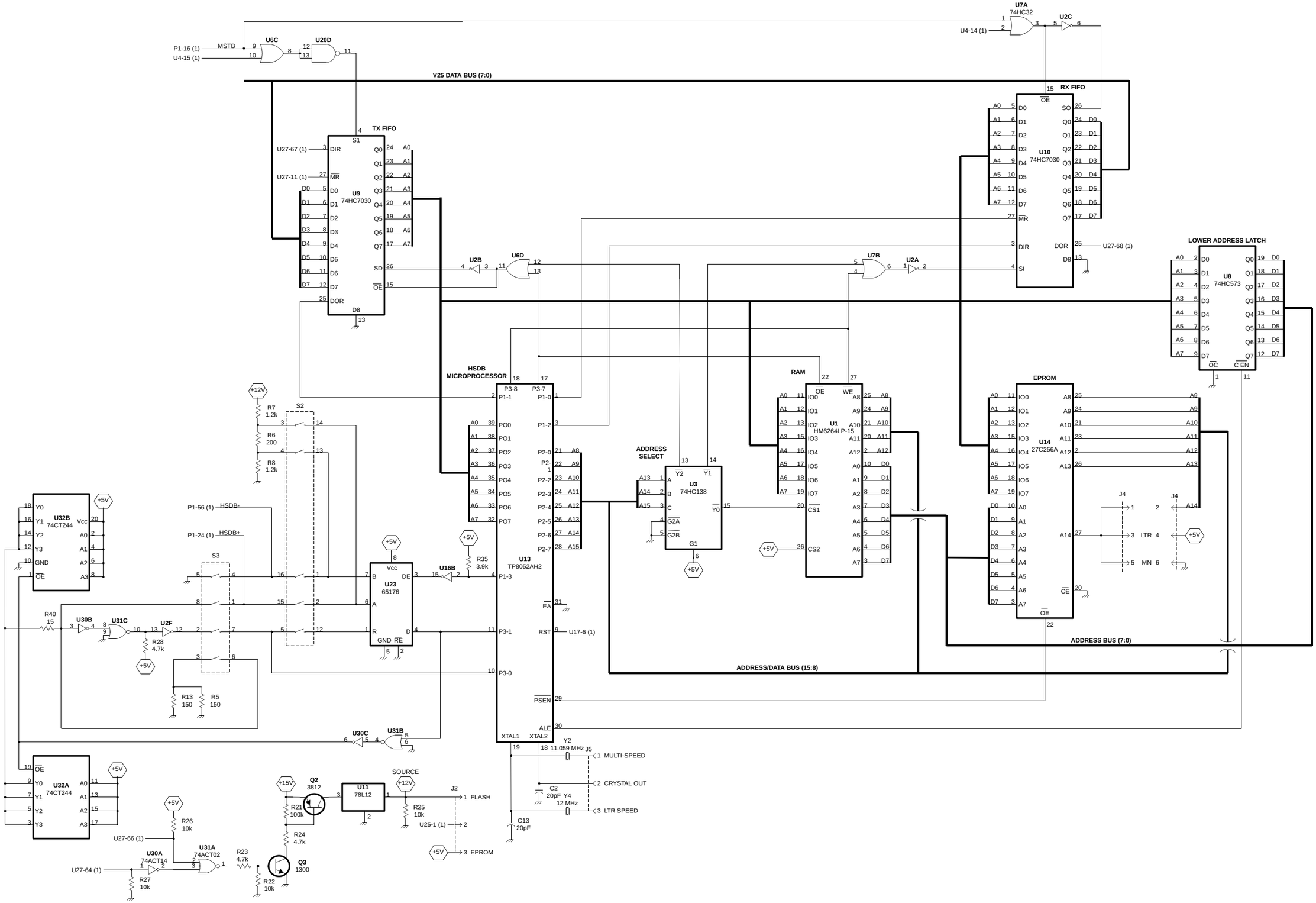
MAIN PROCESSOR CARD SCHEMATIC (1 OF 2)
FIGURE 10-23



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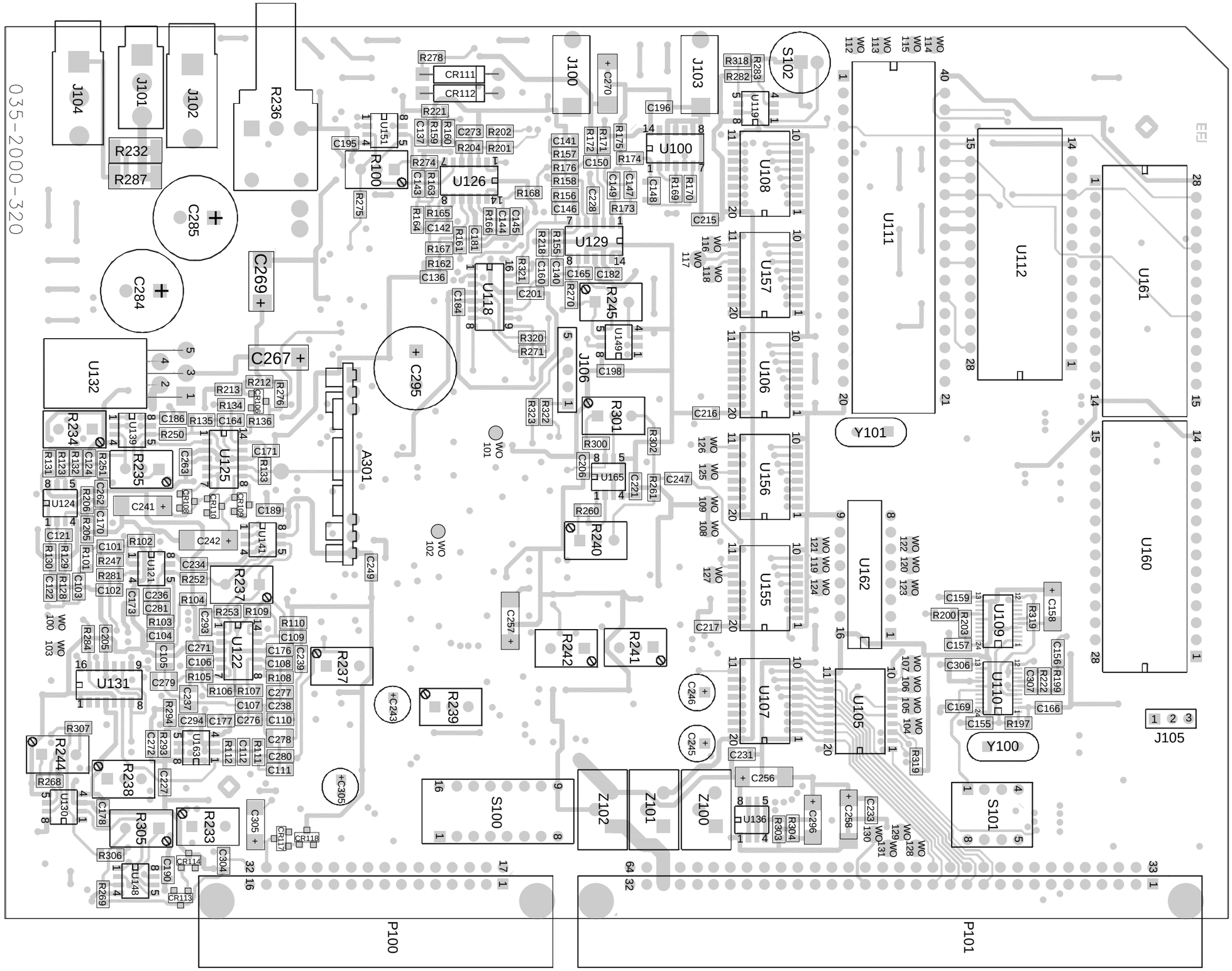
MAIN PROCESSOR CARD SCHEMATIC (2 OF 2)
FIGURE 10-24

FOLDOUT


035-2000-320
J104
J101
J102
R236
R232
R287
C285
C284
C269
C267
U132
R234
R235
R244
R238
R305
R233
U131
R307
R268
R306
R269
C295
A301
C249
C257
R242
R241
R240
R239
R237
C243
C305
C246
C245
C247
C248
C256
C258
C296
C231
C217
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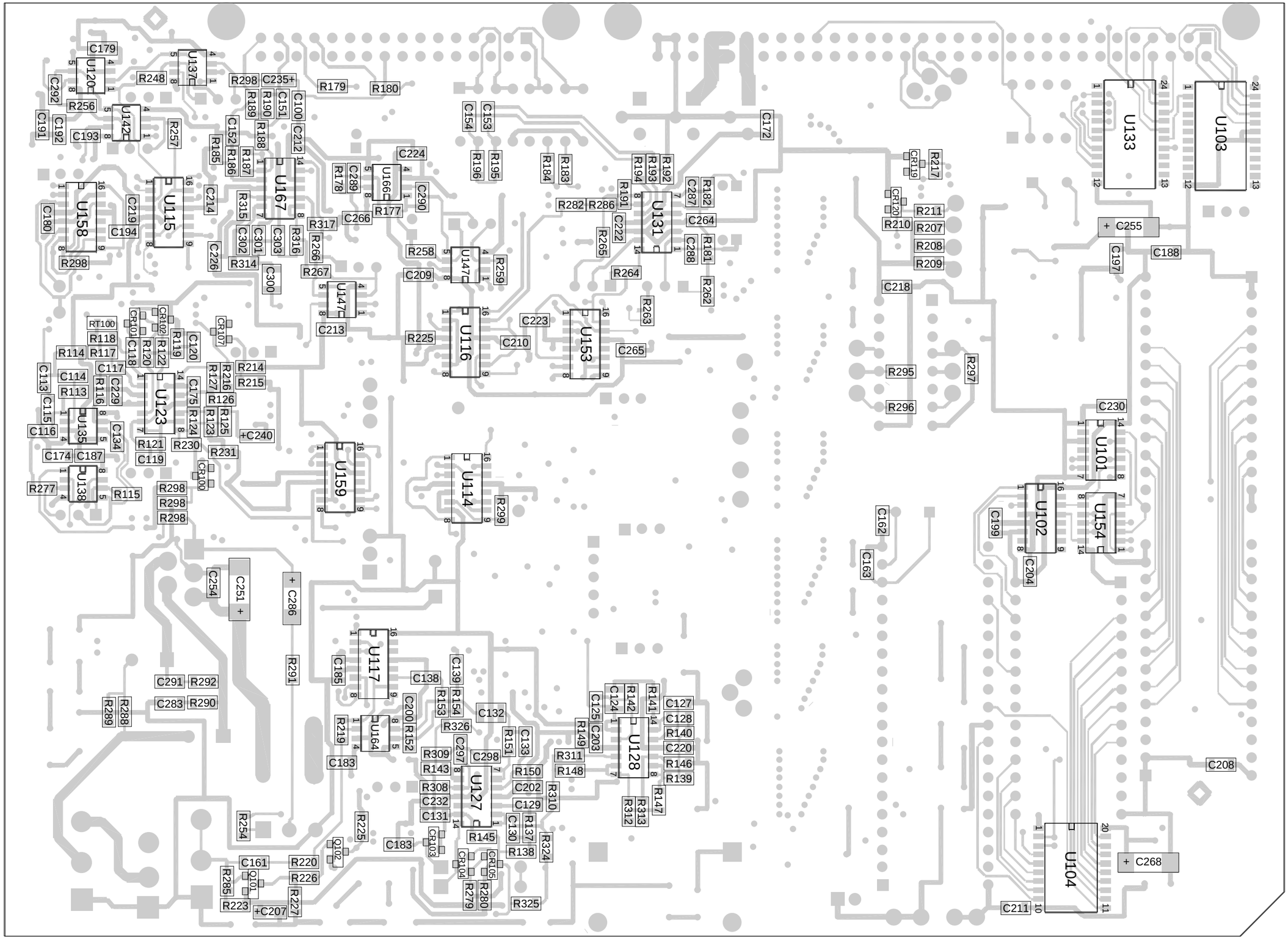
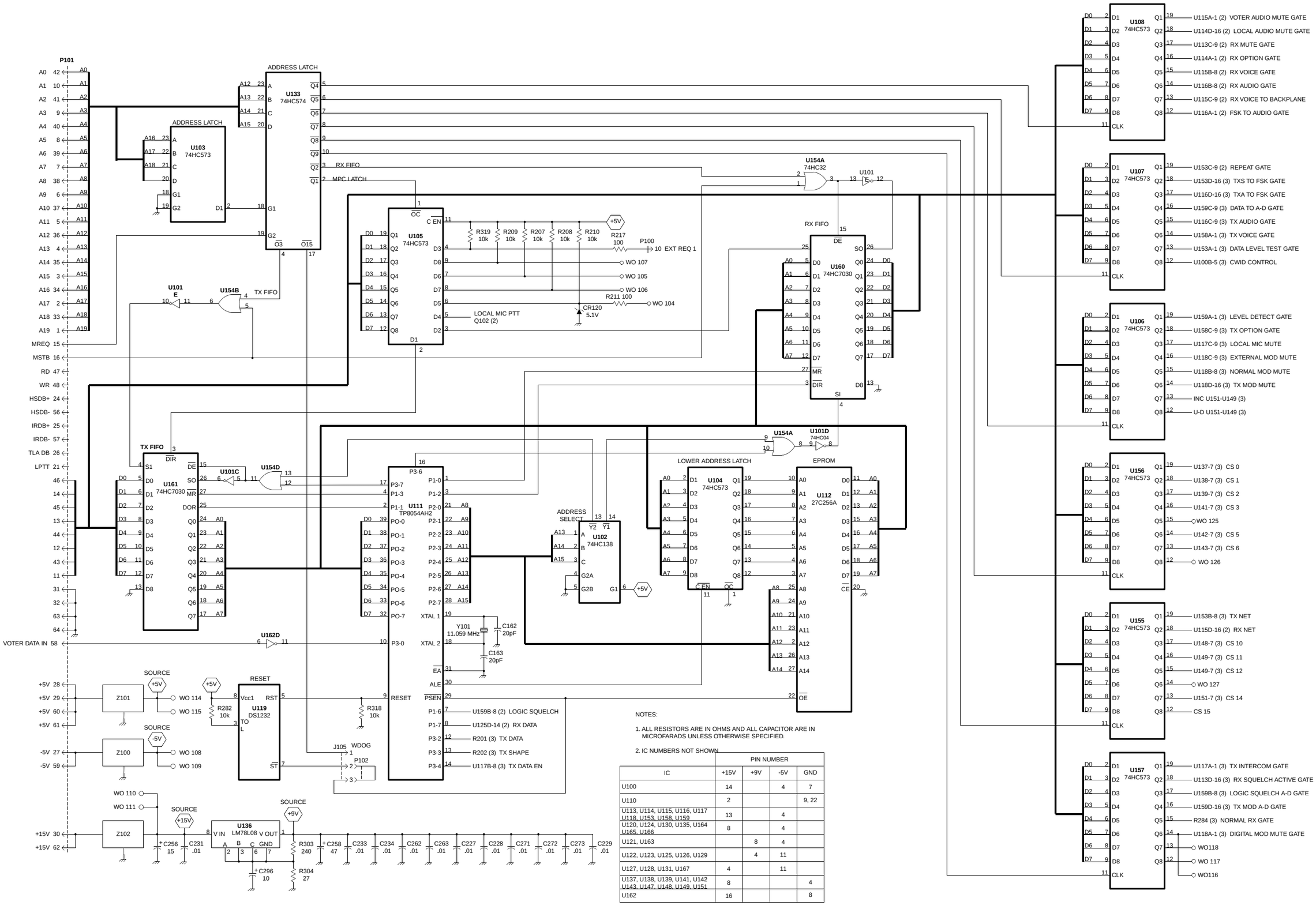
C346



MAIN AUDIO CARD COMPONENT LAYOUT
(OPPOSITE COMPONENT SIDE)
FIGURE 10-26

FOLDOUT →



NOTES:

1. ALL RESISTORS ARE IN OHMS AND ALL CAPACITOR ARE IN MICROFARADS UNLESS OTHERWISE SPECIFIED.

2. IC NUMBERS NOT SHOWN.

IC	PIN NUMBER			
	+15V	+9V	-5V	GND
U100	14		4	7
U110	2			9, 22
U113, U114, U115, U116, U117 U118, U153, U158, U159	13		4	
U120, U124, U130, U135, U164 U165, U166	8		4	
U121, U163		8	4	
U122, U123, U125, U126, U129		4	11	
U127, U128, U131, U167	4		11	
U137, U138, U139, U141, U142 U143, U147, U148, U149, U151	8			4
U162	16			8

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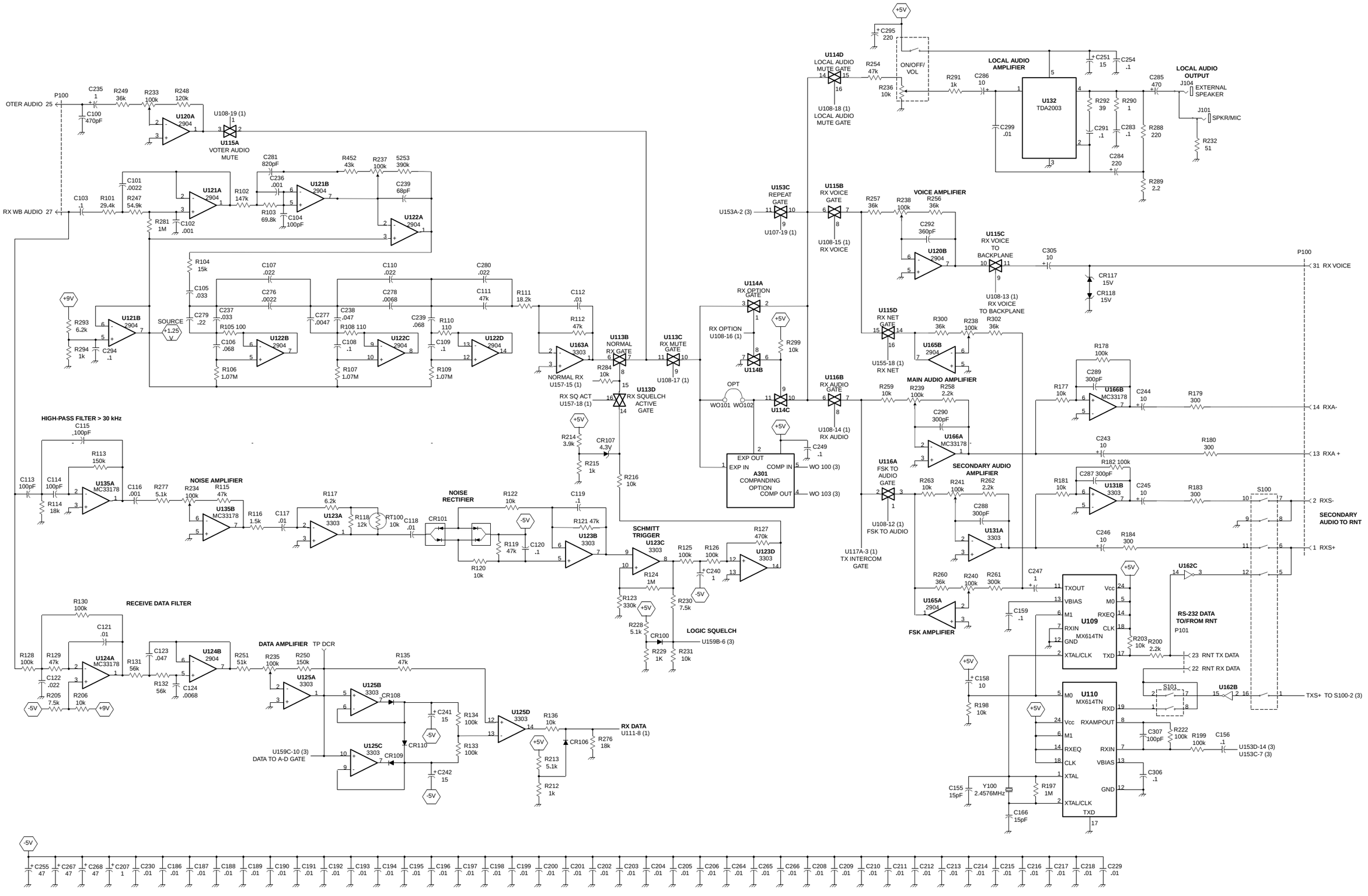
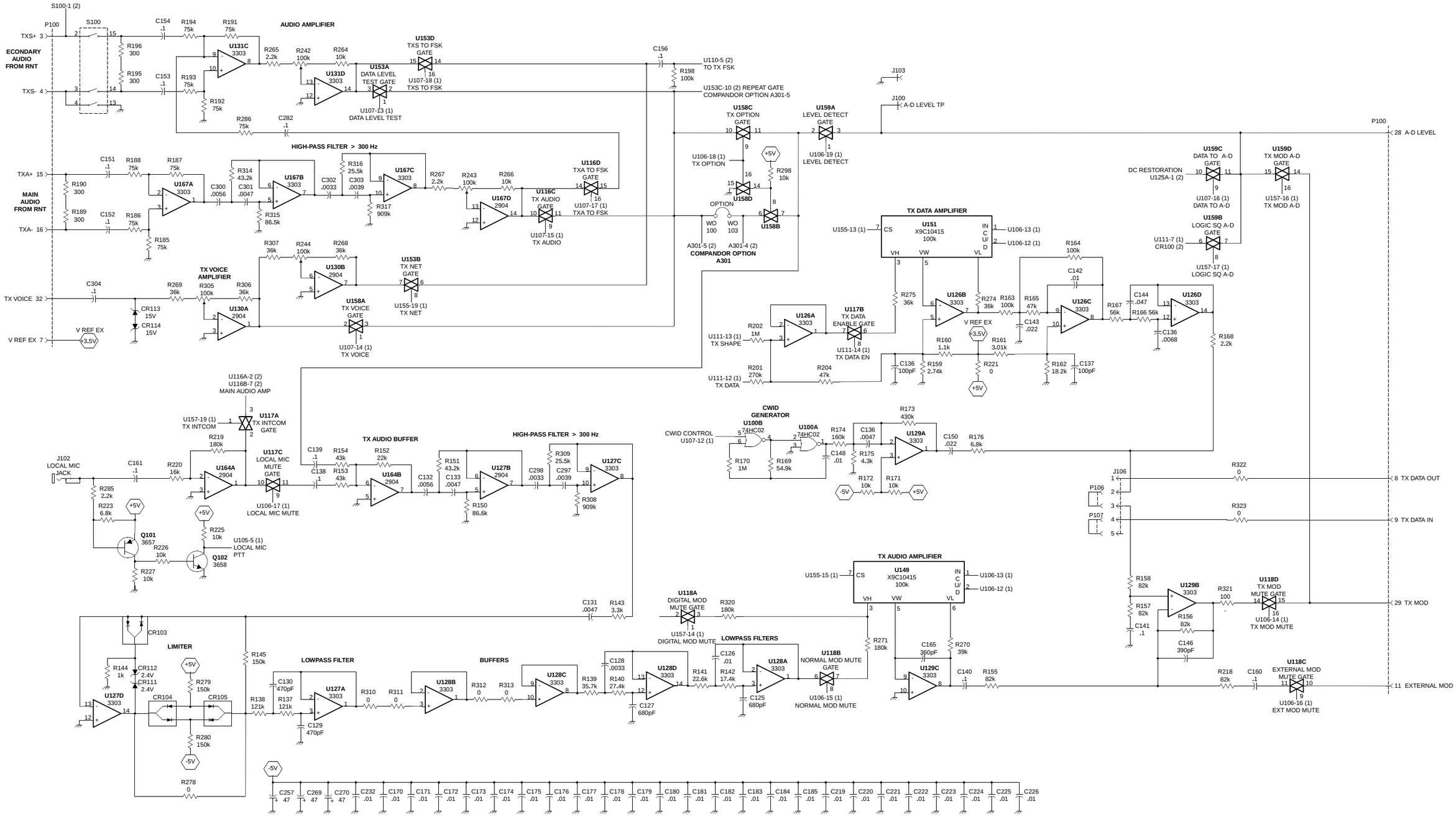
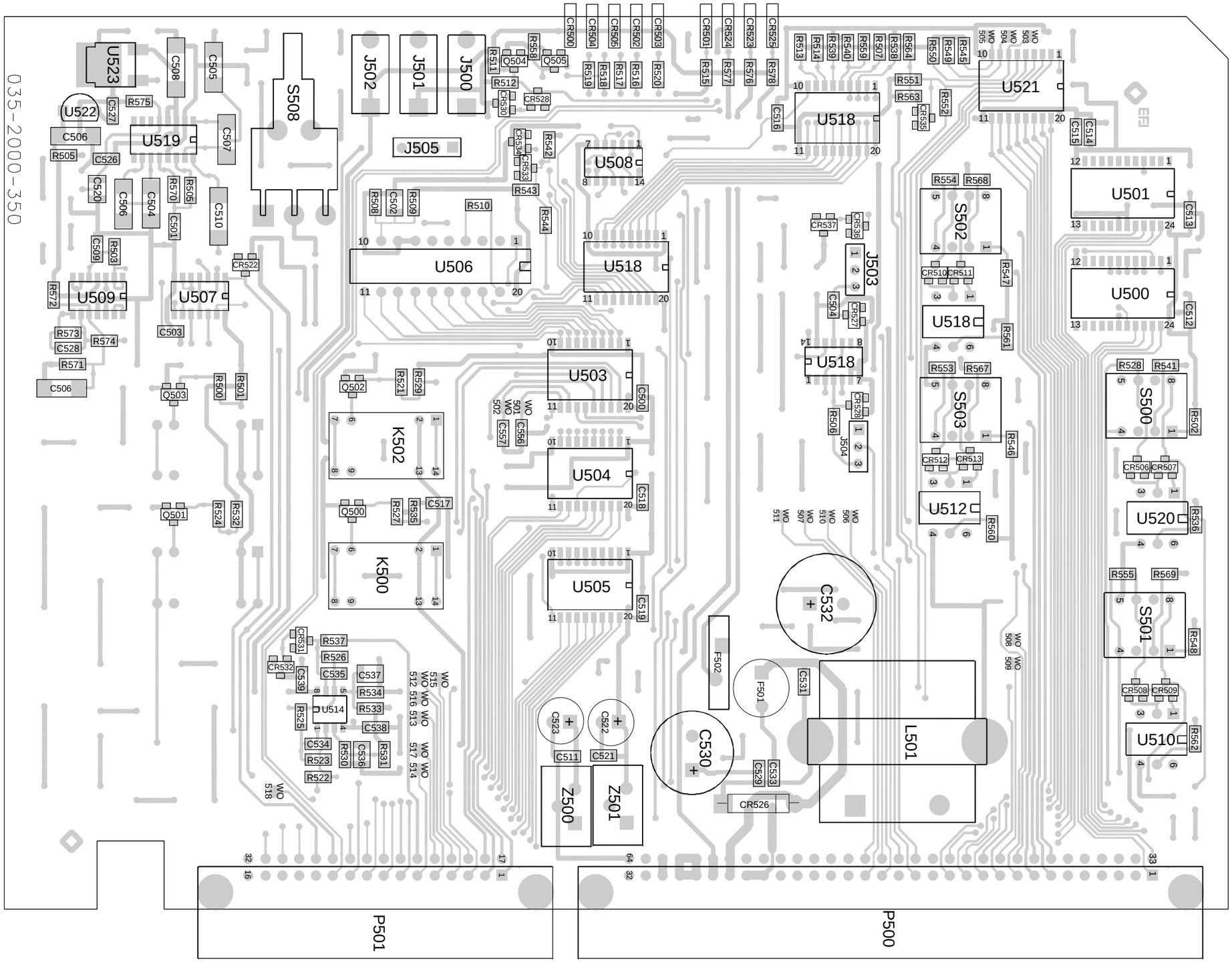
MAIN AUDIO CARD SCHEMATIC (1 OF 3)
FIGURE 10-27


P100
OTER AUDIO 25
RX WB AUDIO 27
U120A 2904
U115A VOTER AUDIO MUTE
U108-19 (1)
U121A 2904
U121B 2904
U122A 2904
U122B 2904
U122C 2904
U122D 2904
SOURCE +1.25 V
+9V
-5V
+5V
U163A 3303
NORMAL RX U157-15 (1)
U113B NORMAL RX GATE
U113C RX MUTE GATE
U108-17 (1)
RX SQ ACT U157-18 (1)
U113D RX SQUELCH ACTIVE GATE
U114A RX OPTION GATE
RX OPTION U108-16 (1)
U114B
OPT
WO101 WO102
U114C
EXP OUT
EXP IN
COMP IN
COMP OUT
A301 COMPANDING OPTION
WO 100 (3)
WO 103 (3)
U114D LOCAL AUDIO MUTE GATE
U108-18 (1) LOCAL AUDIO MUTE GATE
ON/OFF/ VOL
LOCAL AUDIO AMPLIFIER
U132 TDA2003
LOCAL AUDIO OUTPUT
J104 EXTERNAL SPEAKER
J101 SPKR/MIC
U153C REPEAT GATE
U153A-2 (3)
U107-19 (1)
U115B RX VOICE GATE
U108-15 (1) RX VOICE
VOICE AMPLIFIER
U120B 2904
U115C RX VOICE TO BACKPLANE
U108-13 (1) RX VOICE TO BACKPLANE
31 RX VOICE
CR117 15V
CR118 15V
U115D RX NET GATE
U155-18 (1) RX NET
U165B 2904
MAIN AUDIO AMPLIFIER
U116B RX AUDIO GATE
U108-14 (1) RX AUDIO
U166B MC33178
U166A MC33178
14 RXA-
13 RXA +
SECONDARY AUDIO AMPLIFIER
U116A FSK TO AUDIO GATE
U108-12 (1) FSK TO AUDIO
U117A-3 (1) TX INTERCOM GATE
U131B 3303
U131A 3303
S100
2 RXS-
1 RXS+
SECONDARY AUDIO TO RNT
U165A 2904
FSK AMPLIFIER
U109 MX614TN
U110 MX614TN
U162C
U162B
RS-232 DATA TO/FROM RNT
P101
23 RNT TX DATA
22 RNT RX DATA
TXS+ TO S100-2 (3)
U153D-14 (3)
U153C-7 (3)
Y100 2.4576MHz
HIGH-PASS FILTER > 30 kHz
NOISE AMPLIFIER
U135B MC33178
U135A MC33178
NOISE RECTIFIER
U123A 3303
U123B 3303
U123C 3303
U123D 3303
SCHMITT TRIGGER
LOGIC SQUELCH
U159B-6 (3)
RECEIVE DATA FILTER
U124A MC33178
U124B 2904
DATA AMPLIFIER
TP DCR
U125A 3303
U125B 3303
U125C 3303
U125D 3303
U159C-10 (3) DATA TO A-D GATE
RX DATA U111-8 (1)

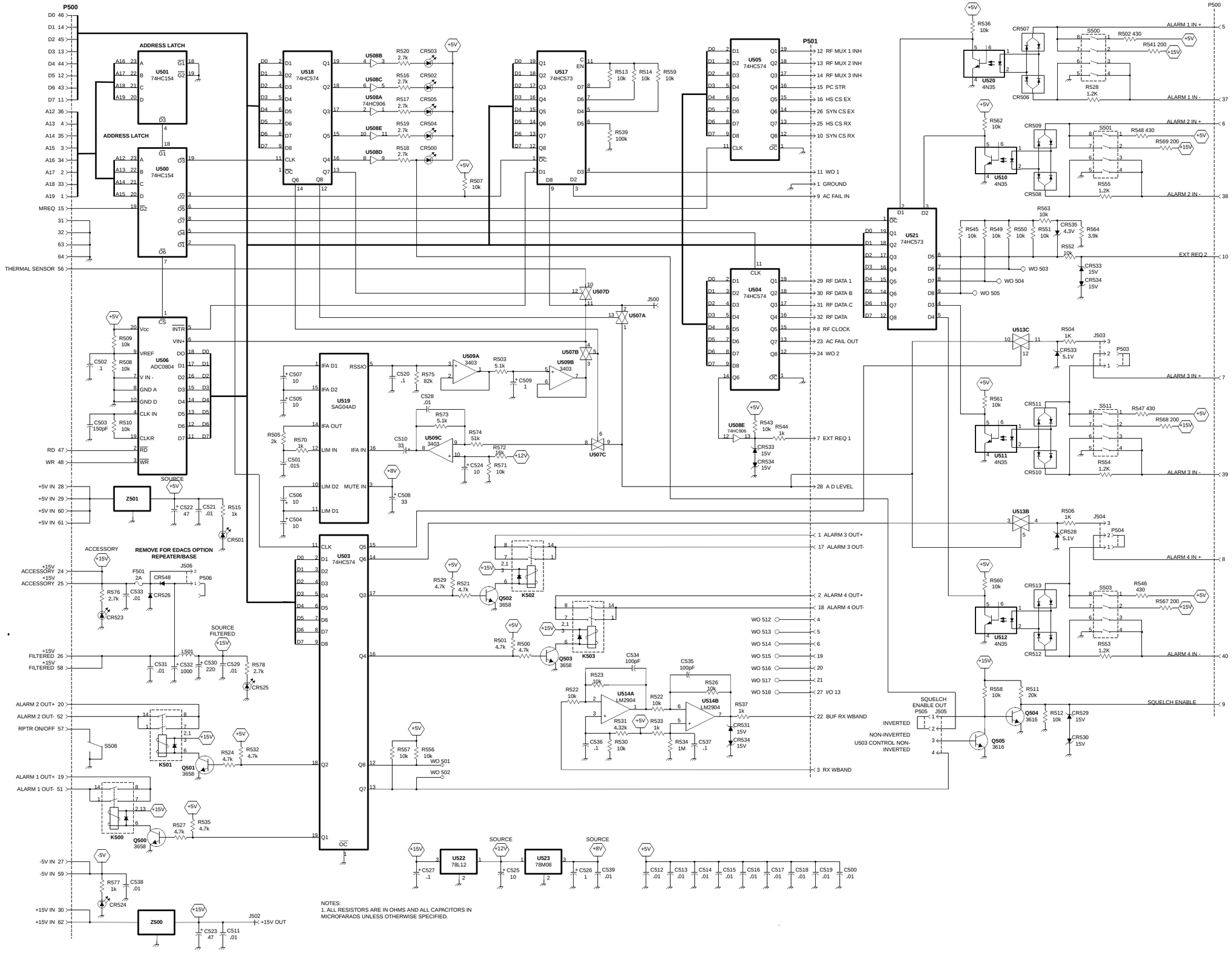


MAIN AUDIO CARD SCHEMATIC (3 OF 3)
FIGURE 10-29



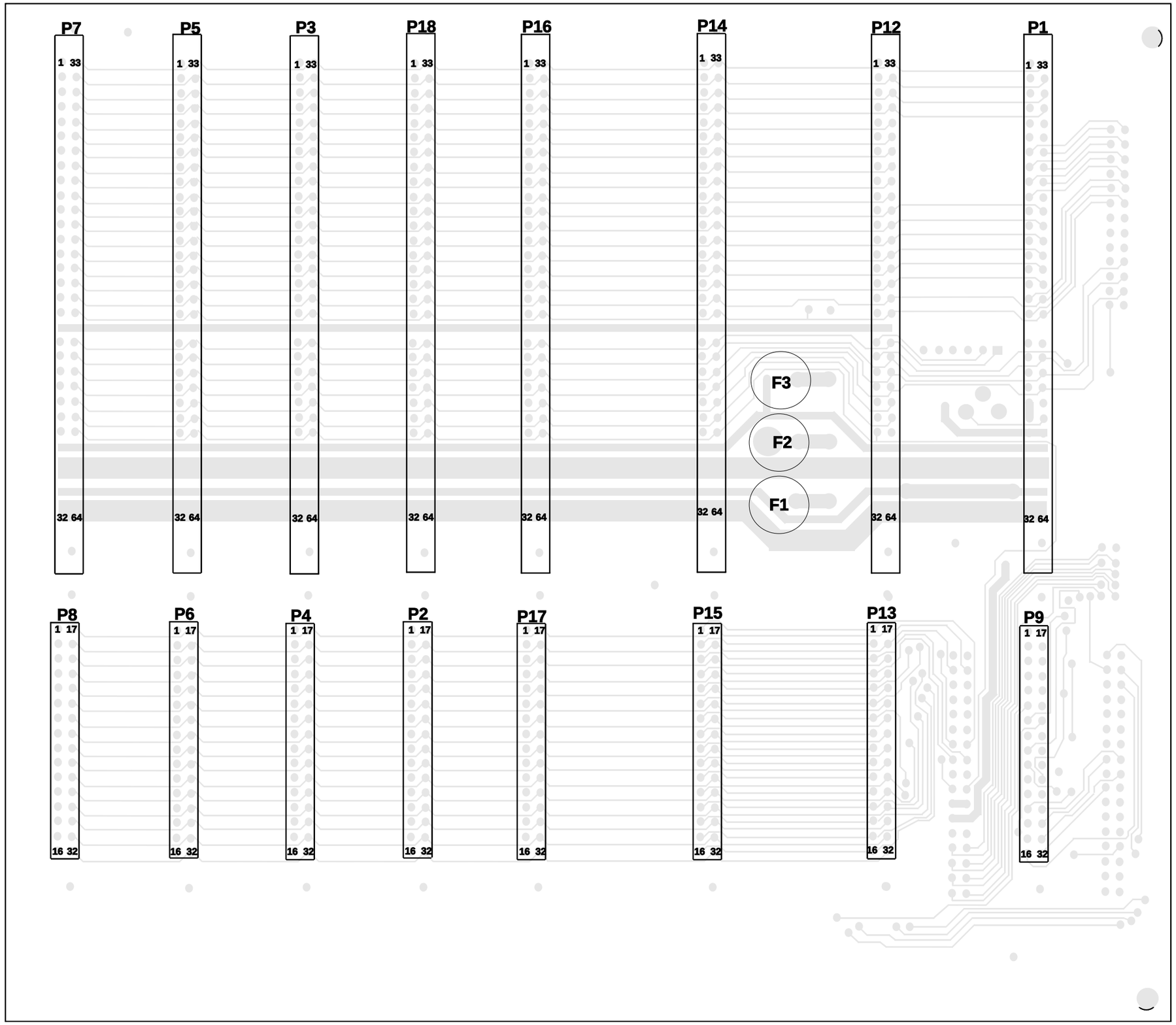
INTERFACE ALARMCARD COMPONENT LAYOUT
FIGURE 10-30

FOLDOUT →



NOTES:
1. ALL RESISTORS ARE IN OHMS AND ALL CAPACITORS IN MICROFARADS UNLESS OTHERWISE SPECIFIED.

INTERFACE ALARM CARD SCHEMATIC
FIGURE 10-31



BACKPLANE COMPONENT LAYOUT (CARD SIDE)
FIGURE 10-32

FOLDOUT →

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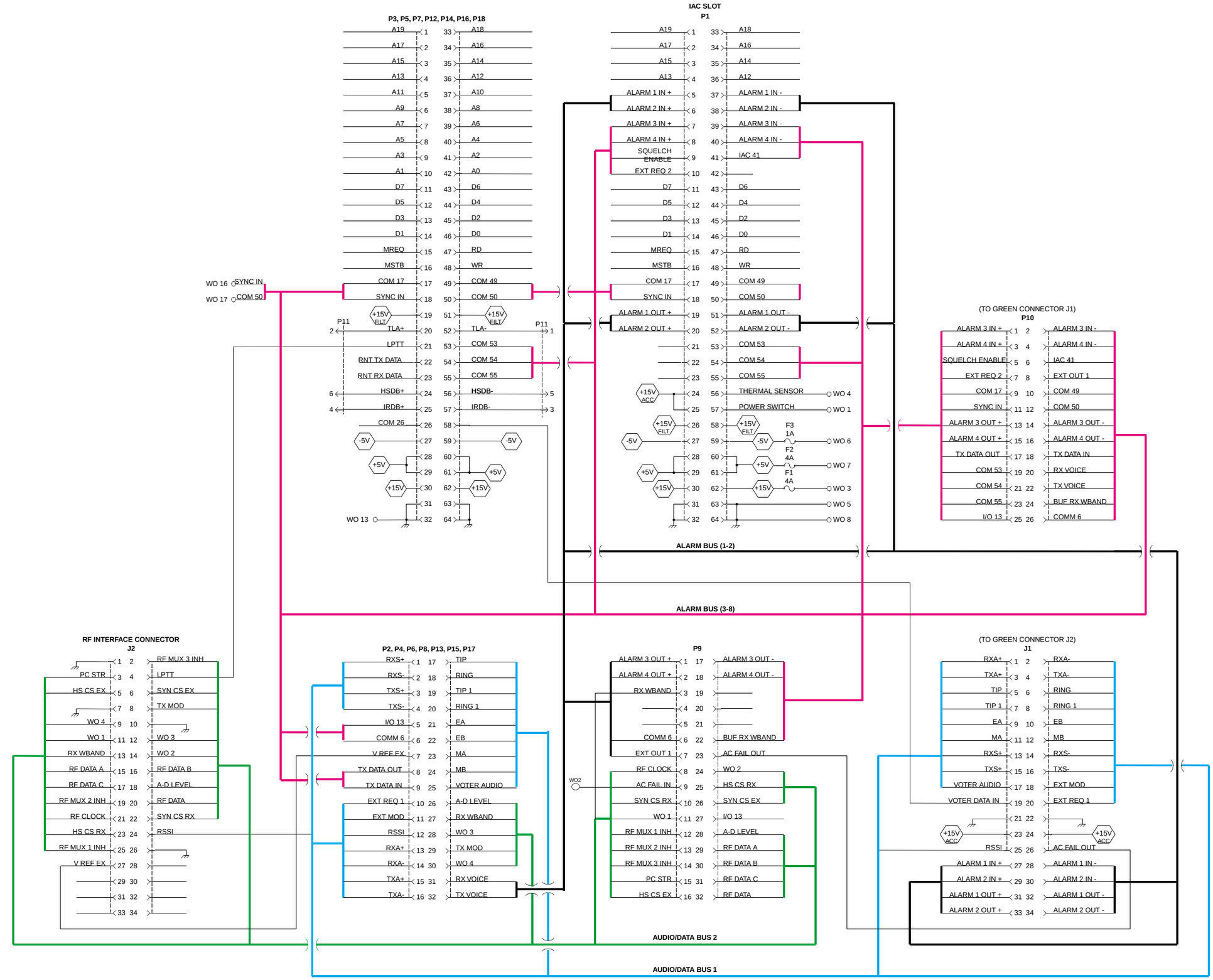
BACKPLANE COMPONENT LAYOUT (CABLE SIDE)
FIGURE 10-33



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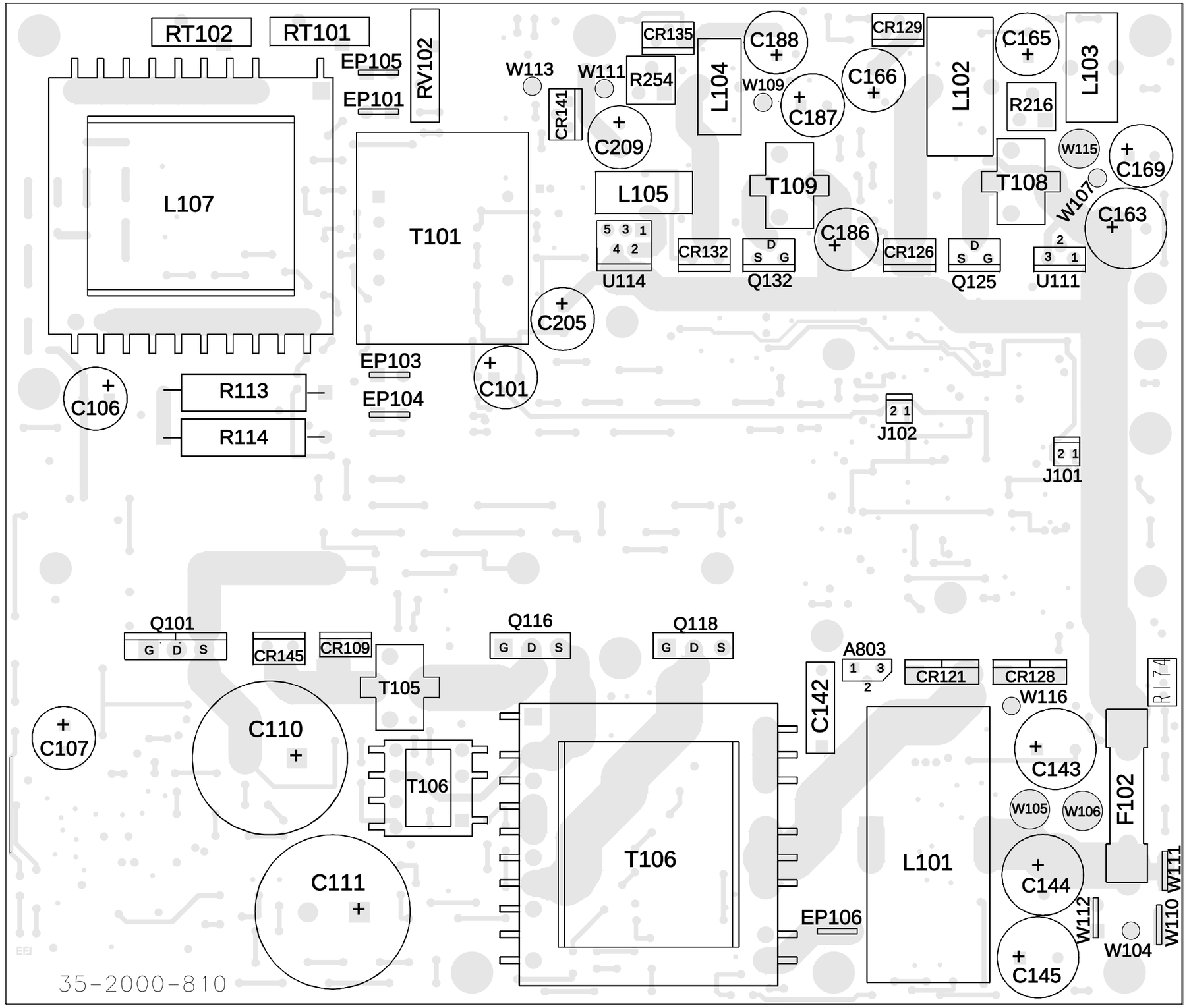
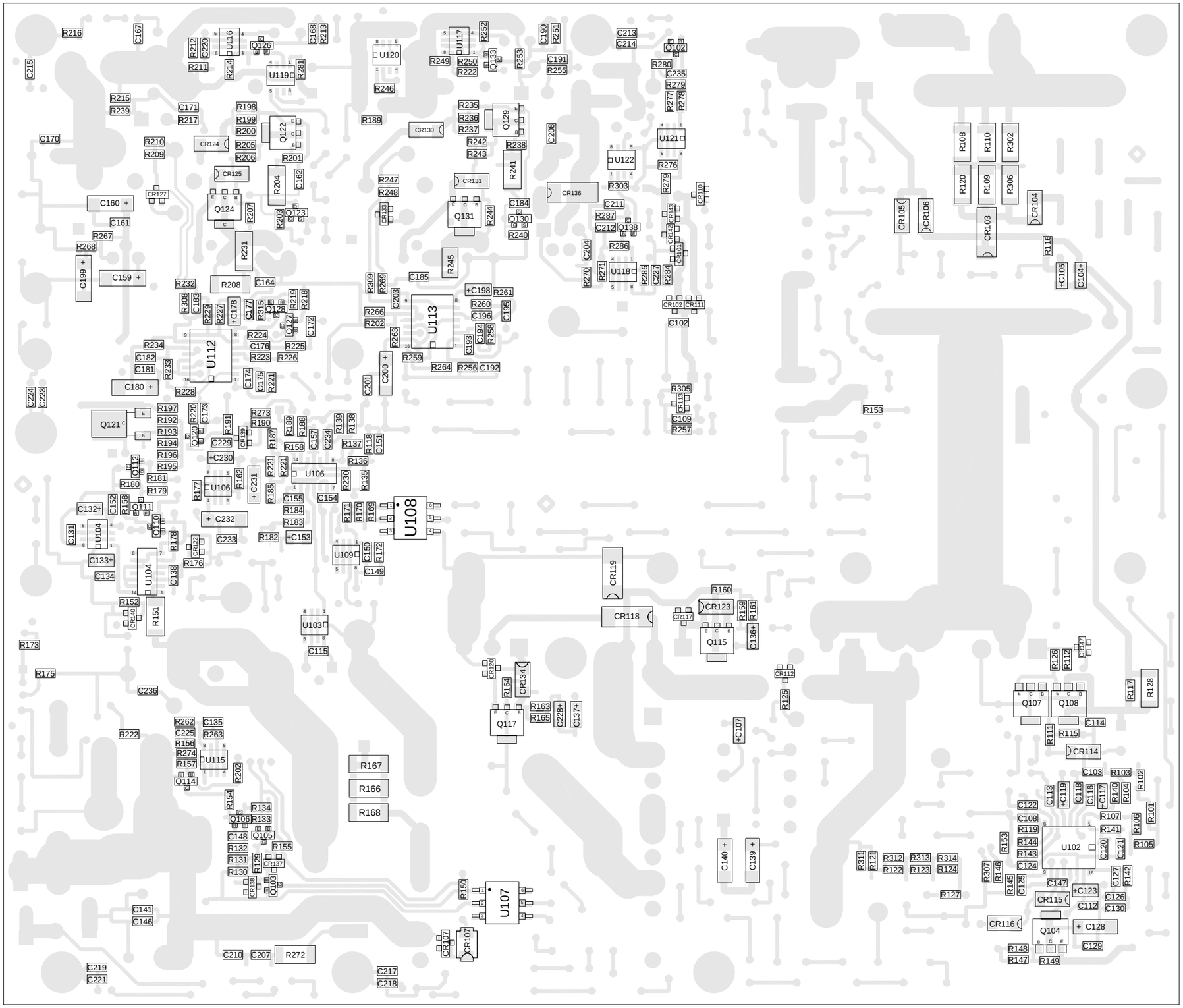
BACKPLANE SCHEMATIC
FIGURE 10-34

FOLDOUT



800W POWER SUPPLY COMPONENT LAYOUT
(COMPONENT SIDE VIEW)
FIGURE 10-35



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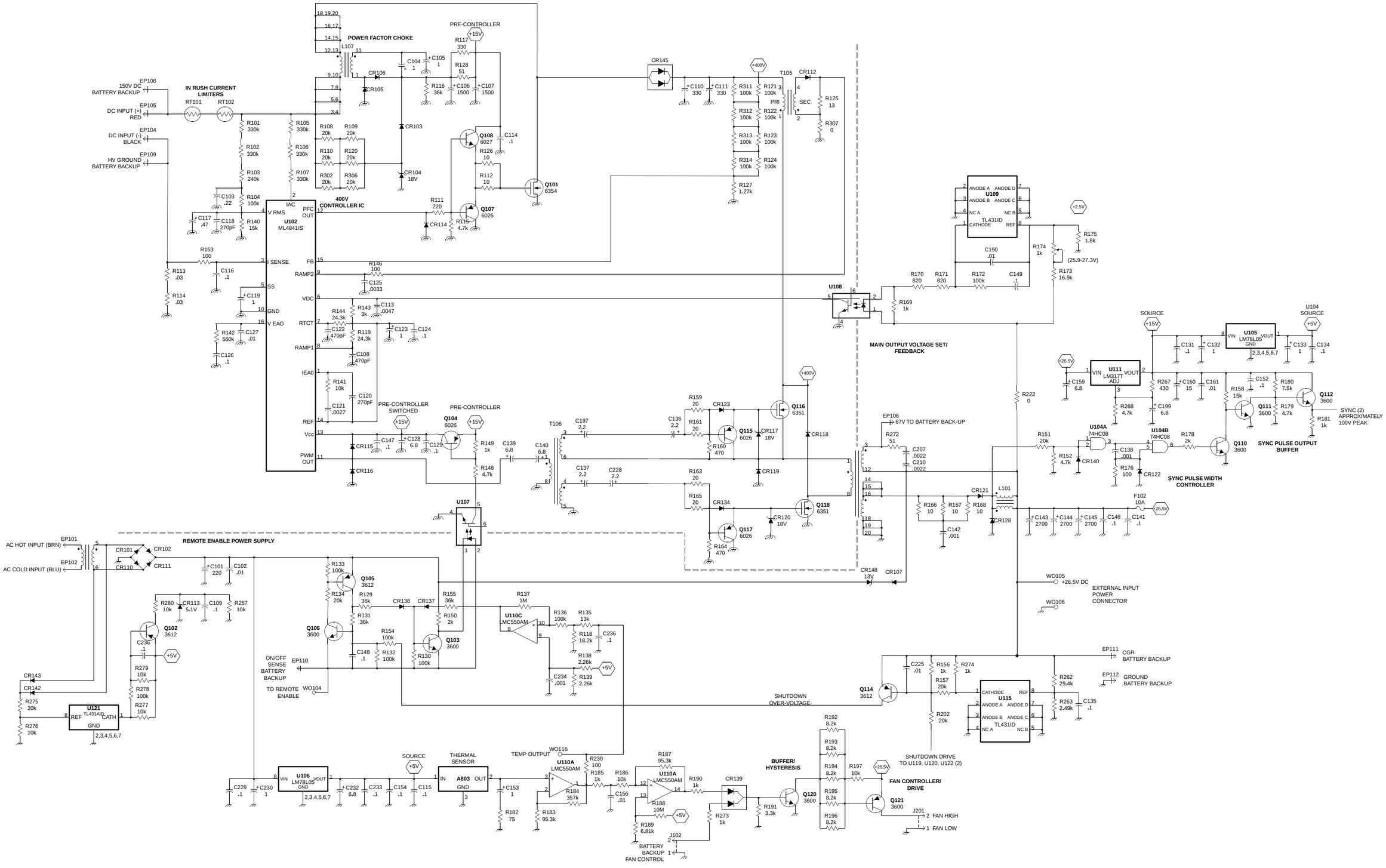
800W POWER SUPPLY COMPONENT LAYOUT
(OPPOSITE COMPONENT SIDE)
FIGURE 10-36

FOLDOUT →



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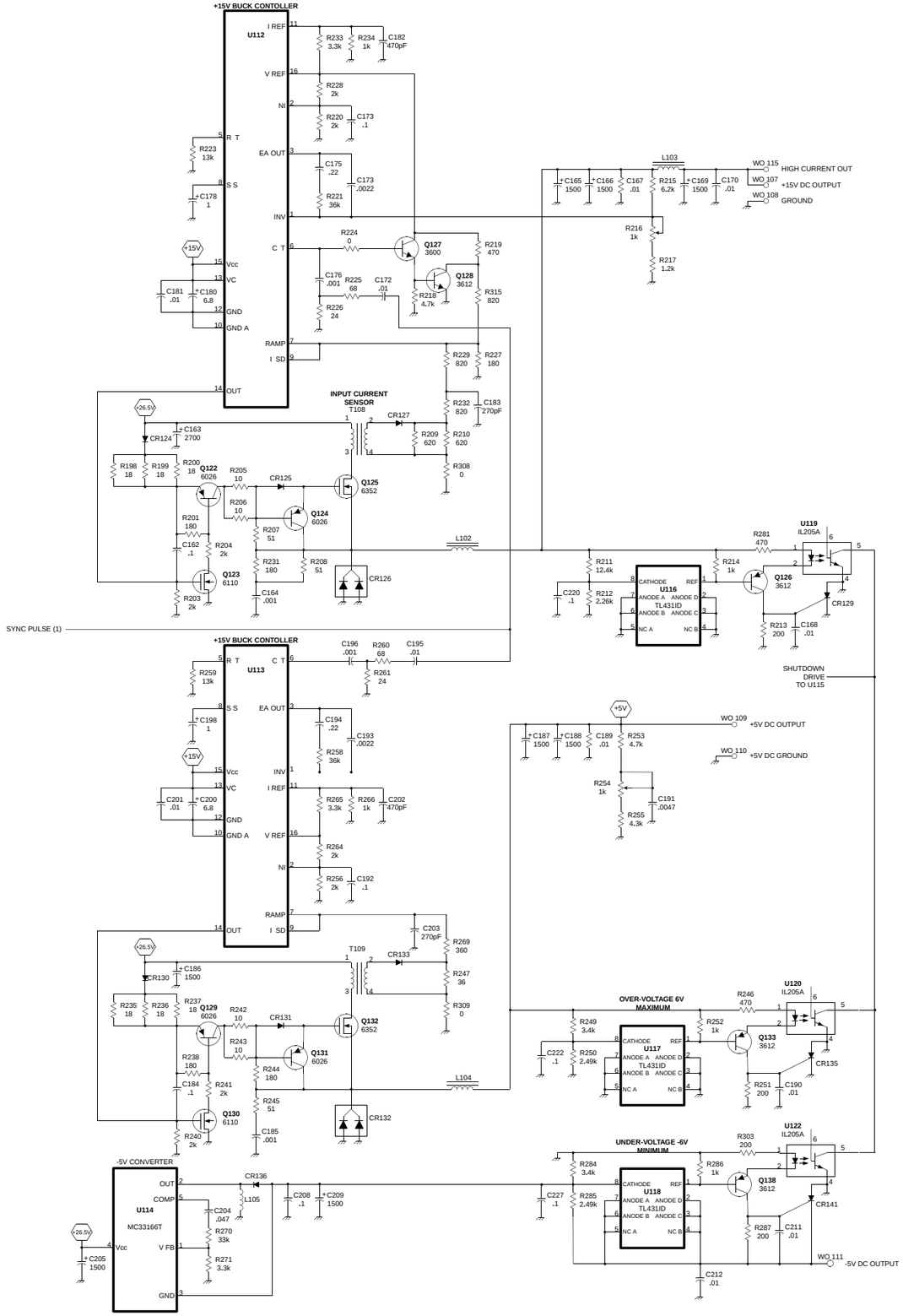
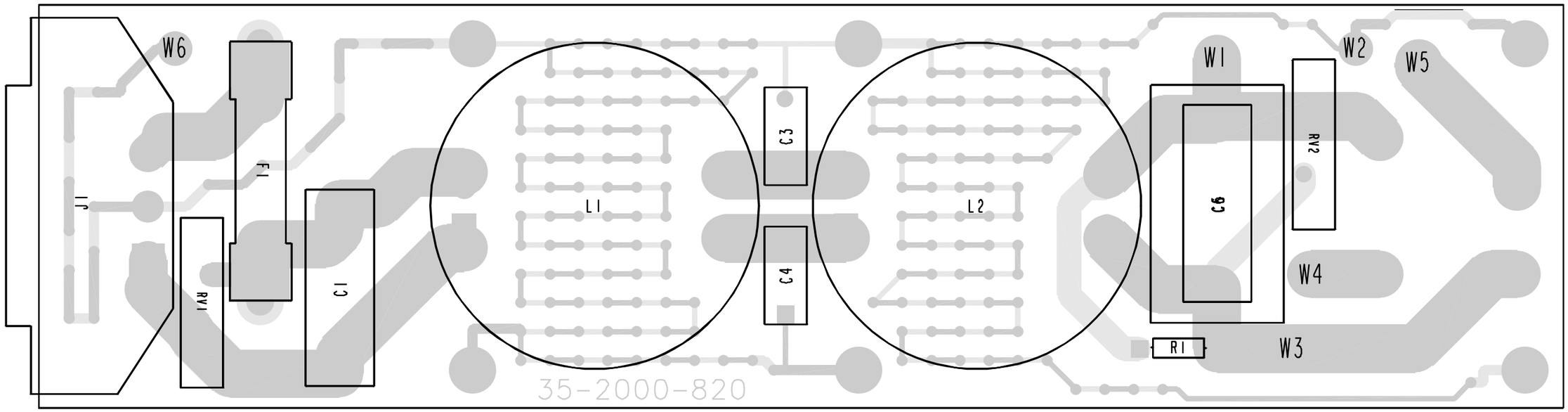
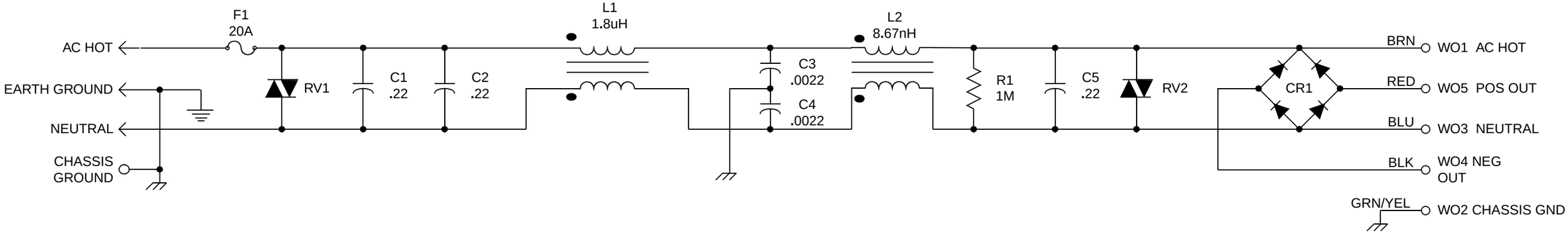
800W POWER SUPPLY SCHEMATIC (1 OF 2)
FIGURE 10-37



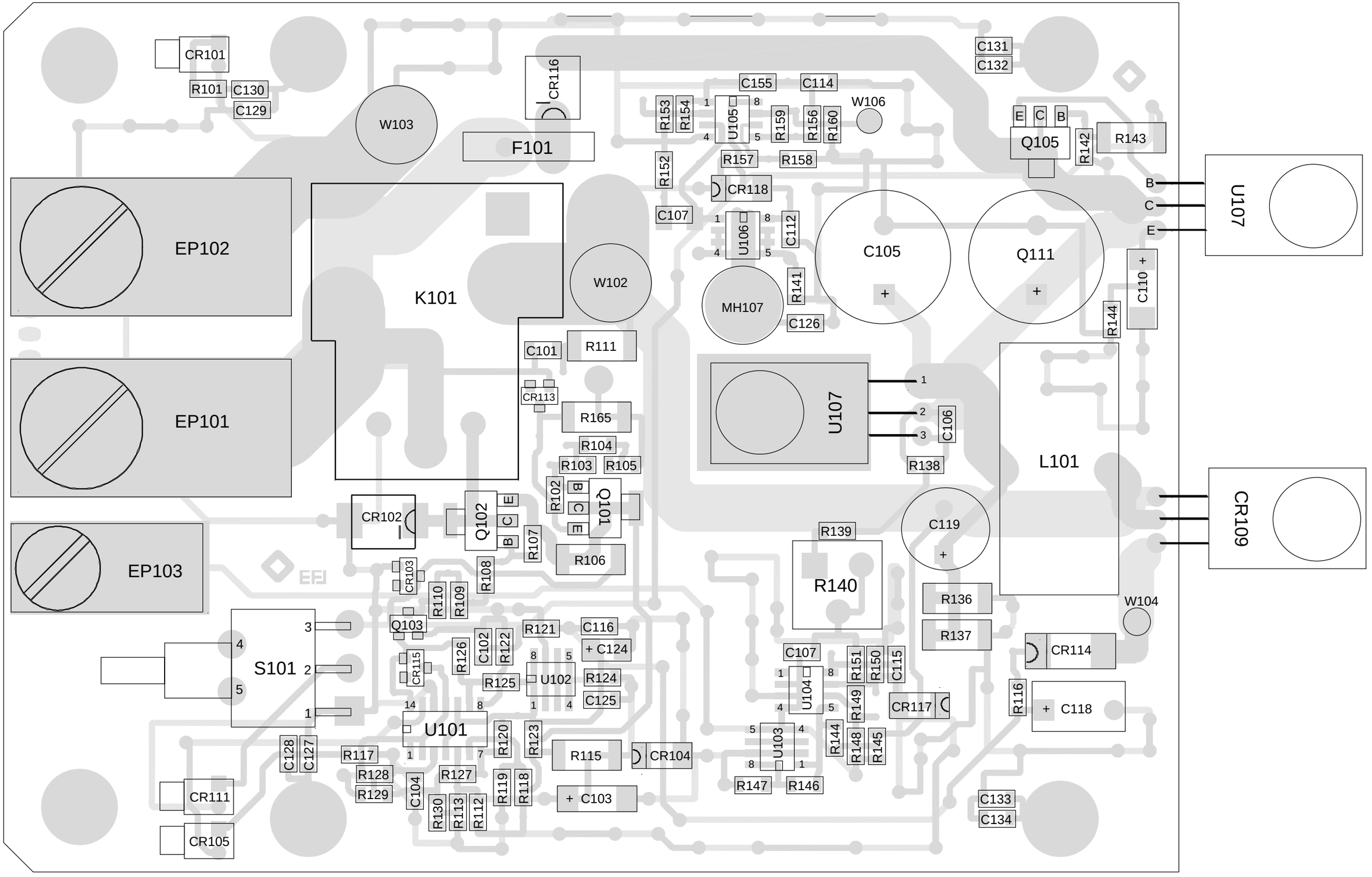
800W POWER SUPPLY SCHEMATIC (2 OF 2)
FIGURE 10-38

FOLDOUT



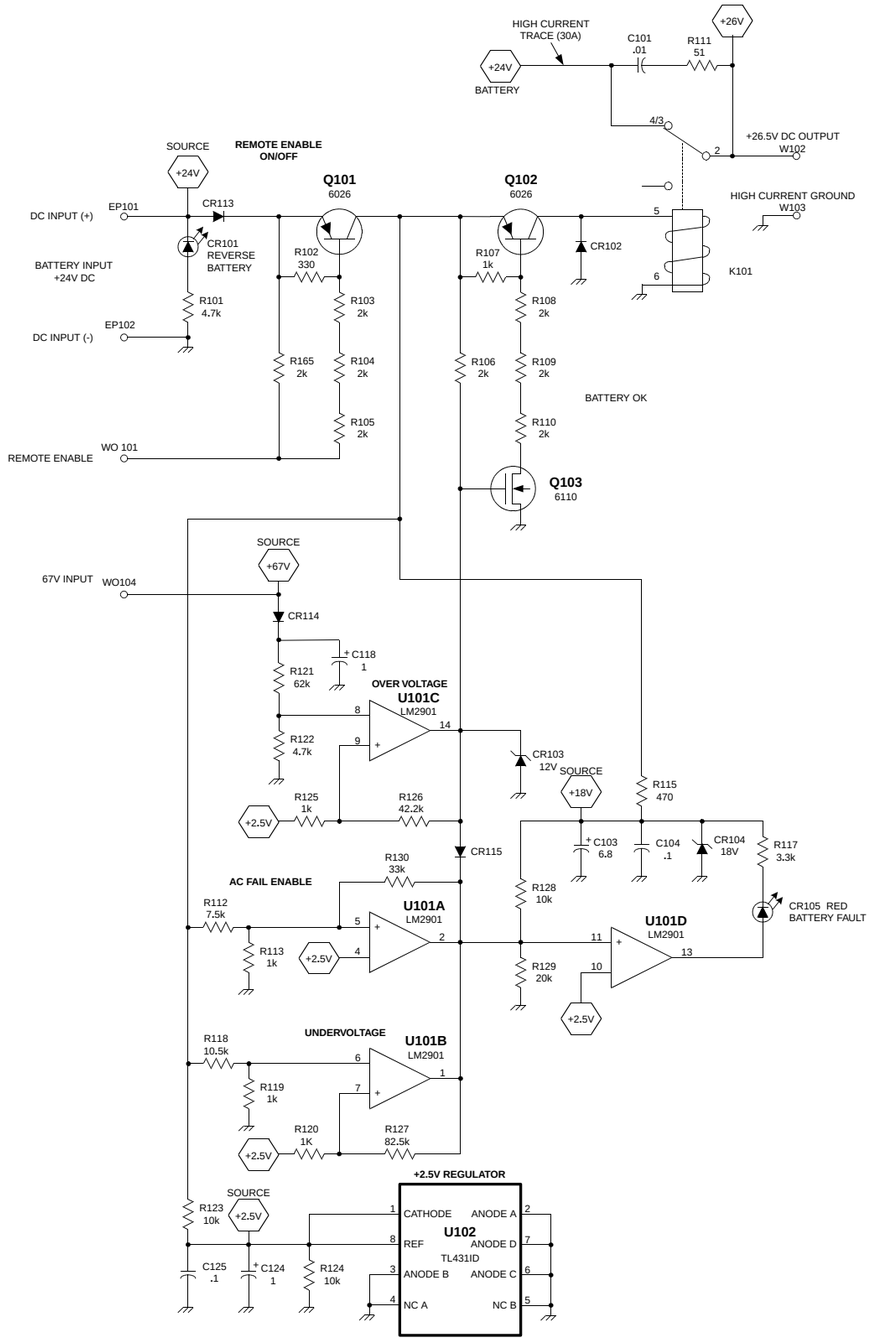


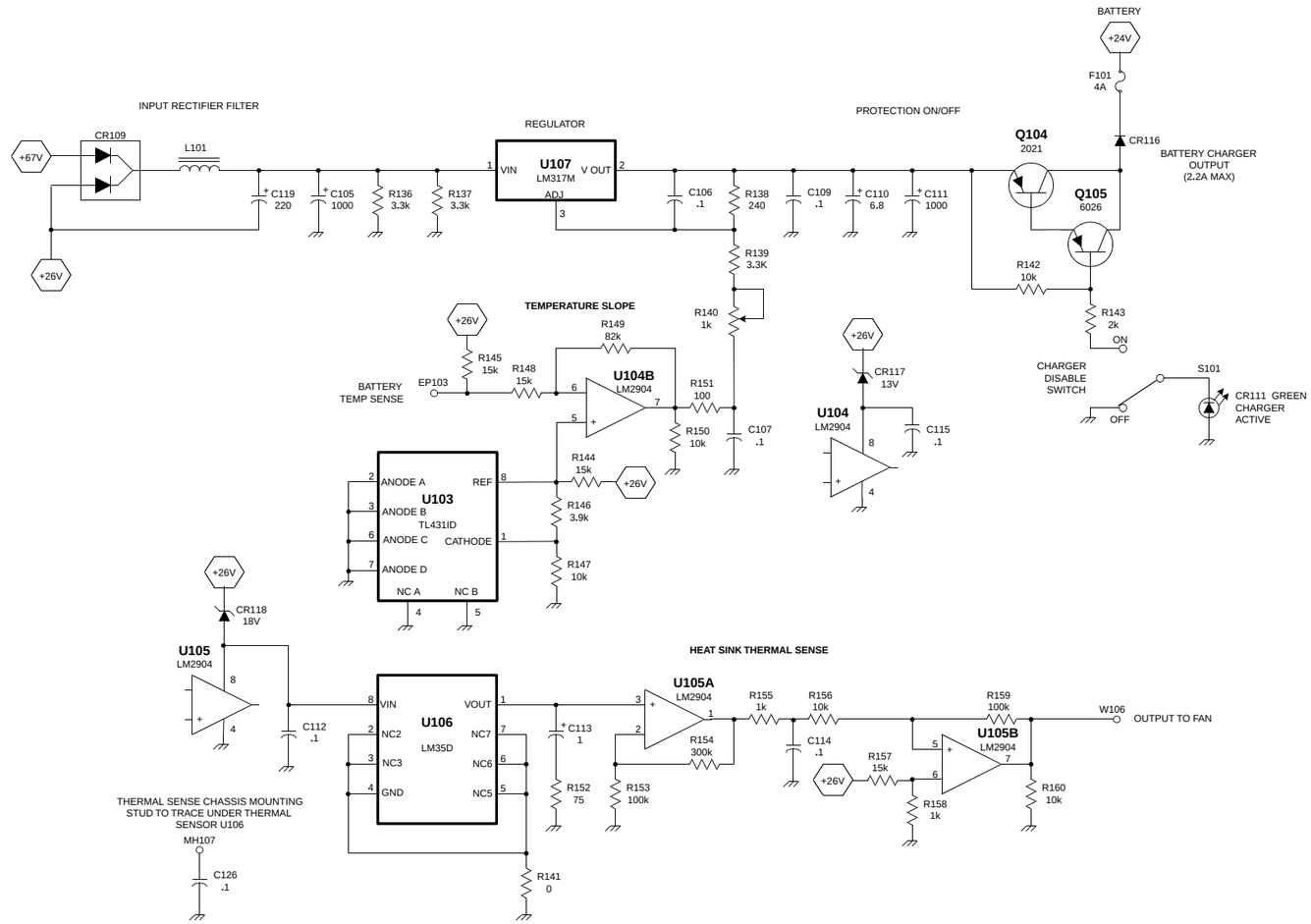
AC FILTER BOARD
FIGURE 10-39



BATTERY BACK-UP COMPONENT LAYOUT
FIGURE 10-40

FOLDOUT





REVERT SECTION

CHARGER SECTION

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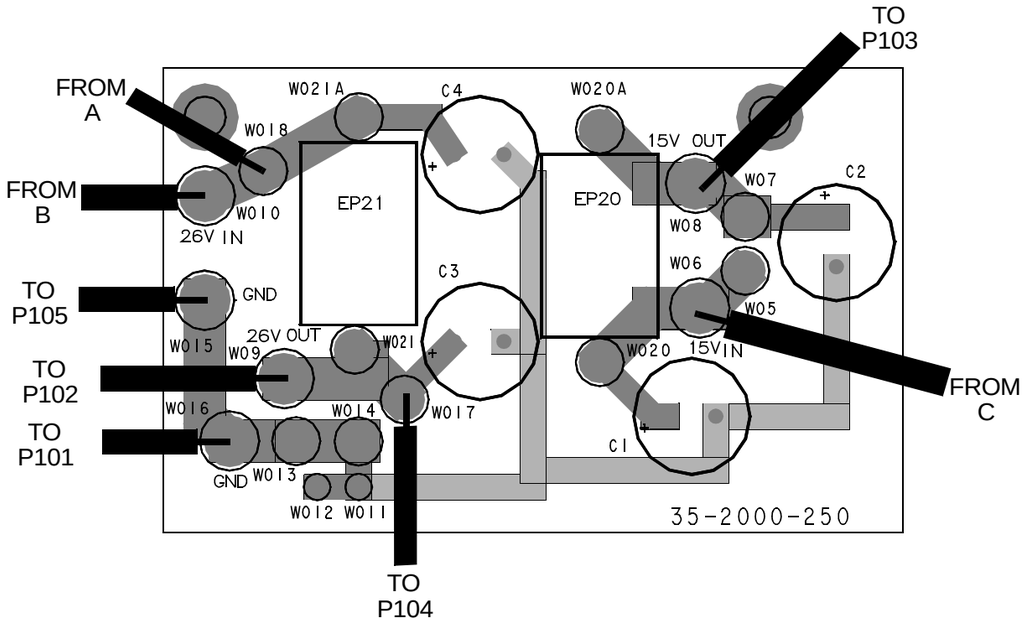
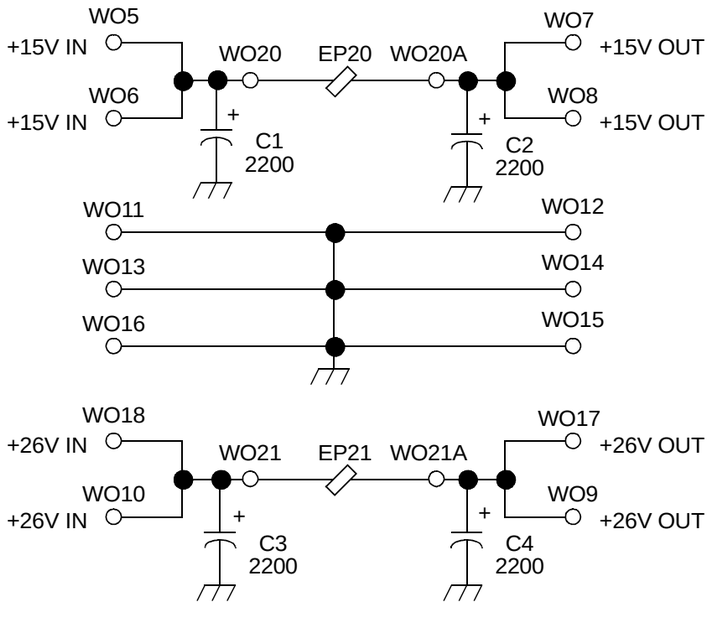
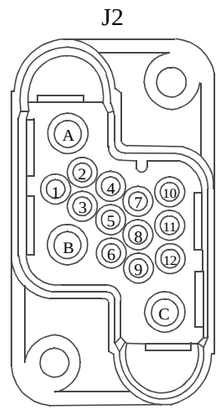
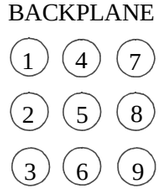
BATTERY BACK-UP SCHEMATIC
FIGURE 10-41

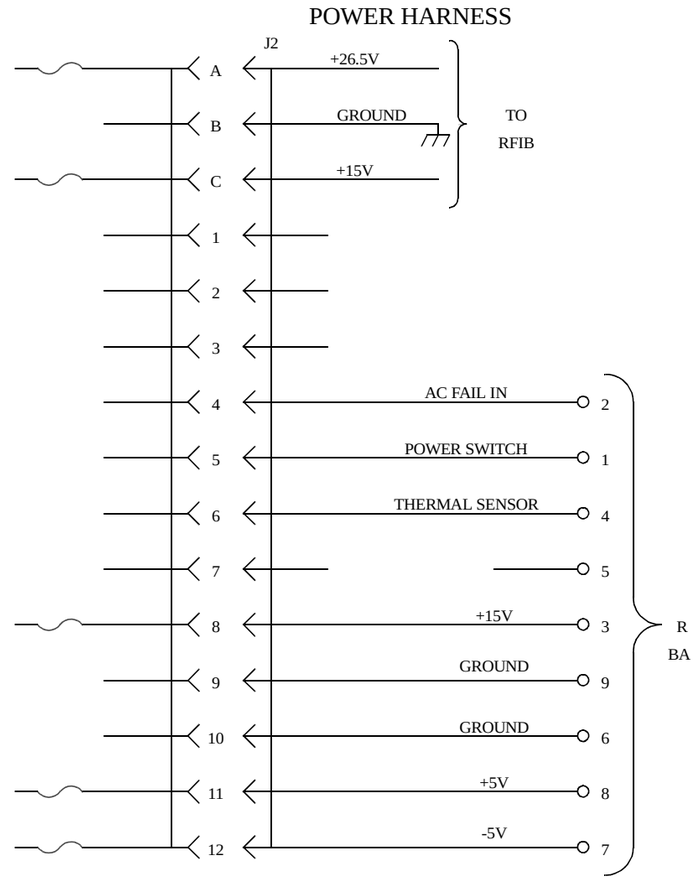




POWER SUPPLY FILTER BOARD
FIGURE 10-42







POWER CABLE CONNECTOR AND SCHEMATIC
FIGURE 10-43

FOLDOUT

SECTION A 800 MHz CHANNEL FREQUENCY CHART

Program Channel Number	FCC Channel Number	Repeater Transmit Frequency	Repeater Receive Frequency	Program Channel Number	FCC Channel Number	Repeater Transmit Frequency	Repeater Receive Frequency
1	1	851.0125	806.0125	45	45	852.1125	807.1125
2	2	851.0375	806.0375	46	46	852.1375	807.1375
3	3	851.0625	806.0625	47	47	852.1625	807.1625
4	4	851.0875	806.0875	48	48	852.1875	807.1875
5	5	851.1125	806.1125	49	49	852.2125	807.2125
6	6	851.1375	806.1375	50	50	852.2375	807.2375
7	7	851.1625	806.1625	51	51	852.2625	807.2625
8	8	851.1875	806.1875	52	52	852.2875	807.2875
9	9	851.2125	806.2125	53	53	852.3125	807.3125
10	10	851.2375	806.2375	54	54	852.3375	807.3375
11	11	851.2625	806.2625	55	55	852.3625	807.3625
12	12	851.2875	806.2875	56	56	852.3875	807.3875
13	13	851.3125	806.3125	57	57	852.4125	807.4125
14	14	851.3375	806.3375	58	58	852.4375	807.4375
15	15	851.3625	806.3625	59	59	852.4625	807.4625
16	16	851.3875	806.3875	60	60	852.4875	807.4875
17	17	851.4125	806.4125	61	61	852.5125	807.5125
18	18	851.4375	806.4375	62	62	852.5375	807.5375
19	19	851.4625	806.4625	63	63	852.5625	807.5625
20	20	851.4875	806.4875	64	64	852.5875	807.5875
21	21	851.5125	806.5125	65	65	852.6125	807.6125
22	22	851.5375	806.5375	66	66	852.6375	807.6375
23	23	851.5625	806.5625	67	67	852.6625	807.6625
24	24	851.5875	806.5875	68	68	852.6875	807.6875
25	25	851.6125	806.6125	69	69	852.7125	807.7125
26	26	851.6375	806.6375	70	70	852.7375	807.7375
27	27	851.6625	806.6625	71	71	852.7625	807.7625
28	28	851.6875	806.6875	72	72	852.7875	807.7875
29	29	851.7125	806.7125	73	73	852.8125	807.8125
30	30	851.7375	806.7375	74	74	852.8375	807.8375
31	31	851.7625	806.7625	75	75	852.8625	807.8625
32	32	851.7875	806.7875	76	76	852.8875	807.8875
33	33	851.8125	806.8125	77	77	852.9125	807.9125
34	34	851.8375	806.8375	78	78	852.9375	807.9375
35	35	851.8625	806.8625	79	79	852.9625	807.9625
36	36	851.8875	806.8875	80	80	852.9875	807.9875
37	37	851.9125	806.9125	81	81	853.0125	808.0125
38	38	851.9375	806.9375	82	82	853.0375	808.0375
39	39	851.9625	806.9625	83	83	853.0625	808.0625
40	40	851.9875	806.9875	84	84	853.0875	808.0875
41	41	852.0125	807.0125	85	85	853.1125	808.1125
42	42	852.0375	807.0375	86	86	853.1375	808.1375
43	43	852.0625	807.0625	87	87	853.1625	808.1625
44	44	852.0875	807.0875	88	88	853.1875	808.1875

Program Channel Number	FCC Channel Number	Repeater Transmit Frequency	Repeater Receive Frequency
89	89	853.2125	808.2125
90	90	853.2375	808.2375
91	91	853.2625	808.2625
92	92	853.2875	808.2875
93	93	853.3125	808.3125
94	94	853.3375	808.3375
95	95	853.3625	808.3625
96	96	853.3875	808.3875
97	97	853.4125	808.4125
98	98	853.4375	808.4375
99	99	853.4625	808.4625
100	100	853.4875	808.4875
101	101	853.5125	808.5125
102	102	853.5375	808.5375
103	103	853.5625	808.5625
104	104	853.5875	808.5875
105	105	853.6125	808.6125
106	106	853.6375	808.6375
107	107	853.6625	808.6625
108	108	853.6875	808.6875
109	109	853.7125	808.7125
110	110	853.7375	808.7375
111	111	853.7625	808.7625
112	112	853.7875	808.7875
113	113	853.8125	808.8125
114	114	853.8375	808.8375
115	115	853.8625	808.8625
116	116	853.8875	808.8875
117	117	853.9125	808.9125
118	118	853.9375	808.9375
119	119	853.9625	808.9625
120	120	853.9875	808.9875
121	121	854.0125	809.0125
122	122	854.0375	809.0375
123	123	854.0625	809.0625
124	124	854.0875	809.0875
125	125	854.1125	809.1125
126	126	854.1375	809.1375
127	127	854.1625	809.1625
128	128	854.1875	809.1875
129	129	854.2125	809.2125
130	130	854.2375	809.2375
131	131	854.2625	809.2625
132	132	854.2875	809.2875
133	133	854.3125	809.3125
134	134	854.3375	809.3375
135	135	854.3625	809.3625
136	136	854.3875	809.3875
137	137	854.4125	809.4125
138	138	854.4375	809.4375
139	139	854.4625	809.4625
140	140	854.4875	809.4875
141	141	854.5125	809.5125
142	142	854.5375	809.5375
143	143	854.5625	809.5625
144	144	854.5875	809.5875
145	145	854.6125	809.6125
146	146	854.6375	809.6375
147	147	854.6625	809.6625
148	148	854.6875	809.6875
149	149	854.7125	809.7125
150	150	854.7375	809.7375
151	151	854.7625	809.7625
152	152	854.7875	809.7875
153	153	854.8125	809.8125
154	154	854.8375	809.8375
155	155	854.8625	809.8625
156	156	854.8875	809.8875
157	157	854.9125	809.9125
158	158	854.9375	809.9375
159	159	854.9625	809.9625
160	160	854.9875	809.9875
161	161	855.0125	810.0125
162	162	855.0375	810.0375
163	163	855.0625	810.0625
164	164	855.0875	810.0875
165	165	855.1125	810.1125
166	166	855.1375	810.1375
167	167	855.1625	810.1625
168	168	855.1875	810.1875
169	169	855.2125	810.2125
170	170	855.2375	810.2375
171	171	855.2625	810.2625
172	172	855.2875	810.2875
173	173	855.3125	810.3125
174	174	855.3375	810.3375
175	175	855.3625	810.3625
176	176	855.3875	810.3875
177	177	855.4125	810.4125

Program Channel Number	FCC Channel Number	Repeater Transmit Frequency	Repeater Receive Frequency	Program Channel Number	FCC Channel Number	Repeater Transmit Frequency	Repeater Receive Frequency
178	178	855.4375	810.4375	221	221	856.5125	811.5125
179	179	855.4625	810.4625	222	222	856.5375	811.5375
180	180	855.4875	810.4875	223	223	856.5625	811.5625
181	181	855.5125	810.5125	224	224	856.5875	811.5875
182	182	855.5375	810.5375	225	225	856.6125	811.6125
183	183	855.5625	810.5625	226	226	856.6375	811.6375
184	184	855.5875	810.5875	227	227	856.6625	811.6625
185	185	855.6125	810.6125	228	228	856.6875	811.6875
186	186	855.6375	810.6375	229	229	856.7125	811.7125
187	187	855.6625	810.6625	230	230	856.7375	811.7375
188	188	855.6875	810.6875	231	231	856.7625	811.7625
189	189	855.7125	810.7125	232	232	856.7875	811.7875
190	190	855.7375	810.7375	233	233	856.8125	811.8125
191	191	855.7625	810.7625	234	234	856.8375	811.8375
192	192	855.7875	810.7875	235	235	856.8625	811.8625
193	193	855.8125	810.8125	236	236	856.8875	811.8875
194	194	855.8375	810.8375	237	237	856.9125	811.9125
195	195	855.8625	810.8625	238	238	856.9375	811.9375
196	196	855.8875	810.8875	239	239	856.9625	811.9625
197	197	855.9125	810.9125	240	240	856.9875	811.9875
198	198	855.9375	810.9375	241	241	857.0125	812.0125
199	199	855.9625	810.9625	242	242	857.0375	812.0375
200	200	855.9875	810.9875	243	243	857.0625	812.0625
201	201	856.0125	811.0125	244	244	857.0875	812.0875
202	202	856.0375	811.0375	245	245	857.1125	812.1125
203	203	856.0625	811.0625	246	246	857.1375	812.1375
204	204	856.0875	811.0875	247	247	857.1625	812.1625
205	205	856.1125	811.1125	249	249	857.2125	812.2125
206	206	856.1375	811.1375	250	250	857.2375	812.2375
207	207	856.1625	811.1625	251	251	857.2625	812.2625
208	208	856.1875	811.1875	252	252	857.2875	812.2875
209	209	856.2125	811.2125	253	253	857.3125	812.3125
210	210	856.2375	811.2375	254	254	857.3375	812.3375
211	211	856.2625	811.2625	255	255	857.3625	812.3625
212	212	856.2875	811.2875	256	256	857.3875	812.3875
213	213	856.3125	811.3125	257	257	857.4125	812.4125
214	214	856.3375	811.3375	258	258	857.4375	812.4375
215	215	856.3625	811.3625	259	259	857.4625	812.4625
216	216	856.3875	811.3875	260	260	857.4875	812.4875
217	217	856.4125	811.4125	261	261	857.5125	812.5125
218	218	856.4375	811.4375	262	262	857.5375	812.5375
219	219	856.4625	811.4625	263	263	857.5625	812.5625
220	220	856.4875	811.4875	264	264	857.5875	812.5875

Program Channel Number	FCC Channel Number	Repeater Transmit Frequency	Repeater Receive Frequency	Program Channel Number	FCC Channel Number	Repeater Transmit Frequency	Repeater Receive Frequency
265	265	857.6125	812.6125	308	308	858.6875	813.6875
266	266	857.6375	812.6375	309	309	858.7125	813.7125
267	267	857.6625	812.6625	310	310	858.7375	813.7375
268	268	857.6875	812.6875	311	311	858.7625	813.7625
269	269	857.7125	812.7125	312	312	858.7875	813.7875
270	270	857.7375	812.7375	313	313	858.8125	813.8125
271	271	857.7625	812.7625	314	314	858.8375	813.8375
272	272	857.7875	812.7875	315	315	858.8625	813.8625
273	273	857.8125	812.8125	316	316	858.8875	813.8875
274	274	857.8375	812.8375	318	318	858.9375	813.9375
275	275	857.8625	812.8625	319	319	858.9625	813.9625
276	276	857.8875	812.8875	320	320	858.9875	813.9875
277	277	857.9125	812.9125	321	321	859.0125	814.0125
278	278	857.9375	812.9375	322	322	859.0375	814.0375
279	279	857.9625	812.9625	323	323	859.0625	814.0625
280	280	857.9875	812.9875	324	324	859.0875	814.0875
281	281	858.0125	813.0125	325	325	859.1125	814.1125
282	282	858.0375	813.0375	326	326	859.1375	814.1375
283	283	858.0625	813.0625	327	327	859.1625	814.1625
284	284	858.0875	813.0875	328	328	859.1875	814.1875
285	285	858.1125	813.1125	329	329	859.2125	814.2125
286	286	858.1375	813.1375	330	330	859.2375	814.2375
287	287	858.1625	813.1625	331	331	859.2625	814.2625
288	288	858.1875	813.1875	332	332	859.2875	814.2875
289	289	858.2125	813.2125	333	333	859.3125	814.3125
290	290	858.2375	813.2375	334	334	859.3375	814.3375
291	291	858.2625	813.2625	335	335	859.3625	814.3625
292	292	858.2875	813.2875	336	336	859.3875	814.3875
293	293	858.3125	813.3125	337	337	859.4125	814.4125
294	294	858.3375	813.3375	338	338	859.4375	814.4375
295	295	858.3625	813.3625	339	339	859.4625	814.4625
296	296	858.3875	813.3875	340	340	859.4875	814.4875
297	297	858.4125	813.4125	341	341	859.5125	814.5125
298	298	858.4375	813.4375	342	342	859.5375	814.5375
299	299	858.4625	813.4625	343	343	859.5625	814.5625
300	300	858.4875	813.4875	344	344	859.5875	814.5875
301	301	858.5125	813.5125	345	345	859.6125	814.6125
302	302	858.5375	813.5375	346	346	859.6375	814.6375
303	303	858.5625	813.5625	347	347	859.6625	814.6625
304	304	858.5875	813.5875	348	348	859.6875	814.6875
305	305	858.6125	813.6125	349	349	859.7125	814.7125
306	306	858.6375	813.6375	350	350	859.7375	814.7375
307	307	858.6625	813.6625	351	351	859.7625	814.7625

Program Channel Number	FCC Channel Number	Repeater Transmit Frequency	Repeater Receive Frequency	Program Channel Number	FCC Channel Number	Repeater Transmit Frequency	Repeater Receive Frequency
352	352	859.7875	814.7875	398	398	860.9375	815.9375
353	353	859.8125	814.8125	399	399	860.9625	815.9625
354	354	859.8375	814.8375	400	400	860.9875	815.9875
355	355	859.8625	814.8625	401	401	861.0125	816.0125
356	356	859.8875	814.8875	402	402	861.0375	816.0375
357	357	859.9125	814.9125	403	403	861.0625	816.0625
358	358	859.9375	814.9375	404	404	861.0875	816.0875
359	359	859.9625	814.9625	405	405	861.1125	816.1125
360	360	859.9875	814.9875	406	406	861.1375	816.1375
361	361	860.0125	815.0125	407	407	861.1625	816.1625
362	362	860.0375	815.0375	408	408	861.1875	816.1875
363	363	860.0625	815.0625	409	409	861.2125	816.2125
364	364	860.0875	815.0875	410	410	861.2375	816.2375
365	365	860.1125	815.1125	411	411	861.2625	816.2625
366	366	860.1375	815.1375	412	412	861.2875	816.2875
367	367	860.1625	815.1625	413	413	861.3125	816.3125
368	368	860.1875	815.1875	414	414	861.3375	816.3375
369	369	860.2125	815.2125	415	415	861.3625	816.3625
370	370	860.2375	815.2375	416	416	861.3875	816.3875
371	371	860.2625	815.2625	417	417	861.4125	816.4125
372	372	860.2875	815.2875	418	418	861.4375	816.4375
373	373	860.3125	815.3125	419	419	861.4625	816.4625
374	374	860.3375	815.3375	420	420	861.4875	816.4875
375	375	860.3625	815.3625	421	421	861.5125	816.5125
376	376	860.3875	815.3875	422	422	861.5375	816.5375
377	377	860.4125	815.4125	423	423	861.5625	816.5625
378	378	860.4375	815.4375	424	424	861.5875	816.5875
379	379	860.4625	815.4625	425	425	861.6125	816.6125
380	380	860.4875	815.4875	426	426	861.6375	816.6375
381	381	860.5125	815.5125	427	427	861.6625	816.6625
382	382	860.5375	815.5375	428	428	861.6875	816.6875
383	383	860.5625	815.5625	429	429	861.7125	816.7125
384	384	860.5875	815.5875	430	430	861.7375	816.7375
385	385	860.6125	815.6125	431	431	861.7625	816.7625
386	386	860.6375	815.6375	432	432	861.7875	816.7875
387	387	860.6625	815.6625	433	433	861.8125	816.8125
388	388	860.6875	815.6875	434	434	861.8375	816.8375
389	389	860.7125	815.7125	435	435	861.8625	816.8625
390	390	860.7375	815.7375	436	436	861.8875	816.8875
391	391	860.7625	815.7625	437	437	861.9125	816.9125
392	392	860.7875	815.7875	438	438	861.9375	816.9375
393	393	860.8125	815.8125	439	439	861.9625	816.9625
394	394	860.8375	815.8375	440	440	861.9875	816.9875
395	395	860.8625	815.8625	441	441	862.0125	817.0125
396	396	860.8875	815.8875	442	442	862.0375	817.0375
397	397	860.9125	815.9125	443	443	862.0625	817.0625

Program Channel Number	FCC Channel Number	Repeater Transmit Frequency	Repeater Receive Frequency	Program Channel Number	FCC Channel Number	Repeater Transmit Frequency	Repeater Receive Frequency
444	444	862.0875	817.0875	490	490	863.2375	818.2375
445	445	862.1125	817.1125	491	491	863.2625	818.2625
446	446	862.1375	817.1375	492	492	863.2875	818.2875
447	447	862.1625	817.1625	493	493	863.3125	818.3125
448	448	862.1875	817.1875	494	494	863.3375	818.3375
449	449	862.2125	817.2125	495	495	863.3625	818.3625
450	450	862.2375	817.2375	496	496	863.3875	818.3875
451	451	862.2625	817.2625	497	497	863.4125	818.4125
452	452	862.2875	817.2875	498	498	863.4375	818.4375
453	453	862.3125	817.3125	499	499	863.4625	818.4625
454	454	862.3375	817.3375	500	500	863.4875	818.4875
455	455	862.3625	817.3625	501	501	863.5125	818.5125
456	456	862.3875	817.3875	502	502	863.5375	818.5375
457	457	862.4125	817.4125	503	503	863.5625	818.5625
458	458	862.4375	817.4375	504	504	863.5875	818.5875
459	459	862.4625	817.4625	505	505	863.6125	818.6125
460	460	862.4875	817.4875	506	506	863.6375	818.6375
461	461	862.5125	817.5125	507	507	863.6625	818.6625
462	462	862.5375	817.5375	508	508	863.6875	818.6875
463	463	862.5625	817.5625	509	509	863.7125	818.7125
464	464	862.5875	817.5875	510	510	863.7375	818.7375
465	465	862.6125	817.6125	511	511	863.7625	818.7625
466	466	862.6375	817.6375	512	512	863.7875	818.7875
467	467	862.6625	817.6625	513	513	863.8125	818.8125
468	468	862.6875	817.6875	514	514	863.8375	818.8375
469	469	862.7125	817.7125	515	515	863.8625	818.8625
470	470	862.7375	817.7375	516	516	863.8875	818.8875
471	471	862.7625	817.7625	517	517	863.9125	818.9125
472	472	862.7875	817.7875	518	518	863.9375	818.9375
473	473	862.8125	817.8125	519	519	863.9625	818.9625
474	474	862.8375	817.8375	520	520	863.9875	818.9875
475	475	862.8625	817.8625	521	521	864.0125	819.0125
476	476	862.8875	817.8875	522	522	864.0375	819.0375
477	477	862.9125	817.9125	523	523	864.0625	819.0625
478	478	862.9375	817.9375	524	524	864.0875	819.0875
479	479	862.9625	817.9625	525	525	864.1125	819.1125
480	480	862.9875	817.9875	526	526	864.1375	819.1375
481	481	863.0125	818.0125	527	527	864.1625	819.1625
482	482	863.0375	818.0375	528	528	864.1875	819.1875
483	483	863.0625	818.0625	529	529	864.2125	819.2125
484	484	863.0875	818.0875	530	530	864.2375	819.2375
485	485	863.1125	818.1125	531	531	864.2625	819.2625
486	486	863.1375	818.1375	532	532	864.2875	819.2875
487	487	863.1625	818.1625	533	533	864.3125	819.3125
488	488	863.1875	818.1875	534	534	864.3375	819.3375
489	489	863.2125	818.2125	535	535	864.3625	819.3625

Program Channel Number	FCC Channel Number	Repeater Transmit Frequency	Repeater Receive Frequency	Program Channel Number	FCC Channel Number	Repeater Transmit Frequency	Repeater Receive Frequency
536	536	864.3875	819.3875	582	582	865.5375	820.5375
537	537	864.4125	819.4125	583	583	865.5625	820.5625
538	538	864.4375	819.4375	584	584	865.5875	820.5875
539	539	864.4625	819.4625	585	585	865.6125	820.6125
540	540	864.4875	819.4875	586	586	865.6375	820.6375
541	541	864.5125	819.5125	587	587	865.6625	820.6625
542	542	864.5375	819.5375	588	588	865.6875	820.6875
543	543	864.5625	819.5625	589	589	865.7125	820.7125
544	544	864.5875	819.5875	590	590	865.7375	820.7375
545	545	864.6125	819.6125	591	591	865.7625	820.7625
546	546	864.6375	819.6375	592	592	865.7875	820.7875
547	547	864.6625	819.6625	593	593	865.8125	820.8125
548	548	864.6875	819.6875	594	594	865.8375	820.8375
549	549	864.7125	819.7125	595	595	865.8625	820.8625
550	550	864.7375	819.7375	596	596	865.8875	820.8875
551	551	864.7625	819.7625	597	597	865.9125	820.9125
552	552	864.7875	819.7875	598	598	865.9375	820.9375
553	553	864.8125	819.8125	599	599	865.9625	820.9625
554	554	864.8375	819.8375	600	600	865.9875	820.9875
555	555	864.8625	819.8625	601	-	866.0000	821.0000
556	556	864.8875	819.8875	602	601	866.0125	821.0125
557	557	864.9125	819.9125	603	-	866.0250	821.0250
558	558	864.9375	819.9375	604	602	866.0375	821.0375
559	559	864.9625	819.9625	605	603	866.0500	821.0500
560	560	864.9875	819.9875	606	604	866.0625	821.0625
561	561	865.0125	820.0125	607	605	866.0750	821.0750
562	562	865.0375	820.0375	608	606	866.0875	821.0875
563	563	865.0625	820.0625	609	607	866.1000	821.1000
564	564	865.0875	820.0875	610	608	866.1125	821.1125
565	565	865.1125	820.1125	611	609	866.1250	821.1250
566	566	865.1375	820.1375	612	610	866.1375	821.1375
567	567	865.1625	820.1625	613	611	866.1500	821.1500
568	568	865.1875	820.1875	614	612	866.1625	821.1625
569	569	865.2125	820.2125	615	613	866.1750	821.1750
570	570	865.2375	820.2375	616	614	866.1875	821.1875
571	571	865.2625	820.2625	617	615	866.2000	821.2000
572	572	865.2875	820.2875	618	616	866.2125	821.2125
573	573	865.3125	820.3125	619	617	866.2250	821.2250
574	574	865.3375	820.3375	620	618	866.2375	821.2375
575	575	865.3625	820.3625	621	619	866.2500	821.2500
576	576	865.3875	820.3875	622	620	866.2625	821.2625
577	577	865.4125	820.4125	623	621	866.2750	821.2750
578	578	865.4375	820.4375	624	622	866.2875	821.2875
579	579	865.4625	820.4625	625	623	866.3000	821.3000
580	580	865.4875	820.4875	626	624	866.3125	821.3125
581	581	865.5125	820.5125	627	625	866.3250	821.3250

Program Channel Number	FCC Channel Number	Repeater Transmit Frequency	Repeater Receive Frequency	Program Channel Number	FCC Channel Number	Repeater Transmit Frequency	Repeater Receive Frequency
628	626	866.3375	821.3375	674	670	866.9125	821.9125
629	627	866.3500	821.3500	675	671	866.9250	821.9250
630	628	866.3625	821.3625	676	672	866.9375	821.9375
631	629	866.3750	821.3750	677	673	866.9500	821.9500
632	630	866.3875	821.3875	678	674	866.9625	821.9625
633	631	866.4000	821.4000	679	675	866.9750	821.9750
634	632	866.4125	821.4125	680	676	866.9875	821.9875
635	633	866.4250	821.4250	681	-	867.0000	822.0000
636	634	866.4375	821.4375	682	677	867.0125	822.0125
637	635	866.4500	821.4500	683	-	867.0250	822.0250
638	636	866.4625	821.4625	684	678	867.0375	822.0375
639	637	866.4750	821.4750	685	679	867.0500	822.0500
640	638	866.4875	821.4875	686	680	867.0625	822.0625
641	-	866.5000	821.5000	687	681	867.0750	822.0750
642	639	866.5125	821.5125	688	682	867.0875	822.0875
643	-	866.5250	821.5250	689	683	867.1000	822.1000
644	640	866.5375	821.5375	690	684	867.1125	822.1125
645	641	866.5500	821.5500	691	685	867.1250	822.1250
646	642	866.5625	821.5625	692	686	867.1375	822.1375
647	643	866.5750	821.5750	693	687	867.1500	822.1500
648	644	866.5875	821.5875	694	688	867.1625	822.1625
649	645	866.6000	821.6000	695	689	867.1750	822.1750
650	646	866.6125	821.6125	696	690	867.1875	822.1875
651	647	866.6250	821.6250	697	691	867.2000	822.2000
652	648	866.6375	821.6375	698	692	867.2125	822.2125
653	649	866.6500	821.6500	699	693	867.2250	822.2250
654	650	866.6625	821.6625	700	694	867.2375	822.2375
655	651	866.6750	821.6750	701	695	867.2500	822.2500
656	652	866.6875	821.6875	702	696	867.2625	822.2625
657	653	866.7000	821.7000	703	697	867.2750	822.2750
658	654	866.7125	821.7125	704	698	867.2875	822.2875
659	655	866.7250	821.7250	705	699	867.3000	822.3000
660	656	866.7375	821.7375	706	700	867.3125	822.3125
661	657	866.7500	821.7500	707	701	867.3250	822.3250
662	658	866.7625	821.7625	708	702	867.3375	822.3375
663	659	866.7750	821.7750	709	703	867.3500	822.3500
664	660	866.7875	821.7875	710	704	867.3625	822.3625
665	661	866.8000	821.8000	711	705	867.3750	822.3750
666	662	866.8125	821.8125	712	706	867.3875	822.3875
667	663	866.8250	821.8250	713	707	867.4000	822.4000
668	664	866.8375	821.8375	714	708	867.4125	822.4125
669	665	866.8500	821.8500	715	709	867.4250	822.4250
670	666	866.8625	821.8625	716	710	867.4375	822.4375
671	667	866.8750	821.8750	717	711	867.4500	822.4500
672	668	866.8875	821.8875	718	712	867.4625	822.4625
673	669	866.9000	821.9000	719	713	867.4750	822.4750

Program Channel Number	FCC Channel Number	Repeater Transmit Frequency	Repeater Receive Frequency	Program Channel Number	FCC Channel Number	Repeater Transmit Frequency	Repeater Receive Frequency
720	714	867.4875	822.4875	767	757	868.0750	823.0750
721	-	867.5000	822.5000	768	758	868.0875	823.0875
722	715	867.5125	822.5125	769	759	868.1000	823.1000
723	-	867.5250	822.5250	770	760	868.1125	823.1125
724	716	867.5375	822.5375	771	761	868.1250	823.1250
725	717	867.5500	822.5500	772	762	868.1375	823.1375
726	718	867.5625	822.5625	773	763	868.1500	823.1500
727	719	867.5750	822.5750	774	764	868.1625	823.1625
728	720	867.5875	822.5875	775	765	868.1750	823.1750
729	721	867.6000	822.6000	776	766	868.1875	823.1875
731	723	867.6250	822.6250	777	767	868.2000	823.2000
732	724	867.6375	822.6375	778	768	868.2125	823.2125
733	725	867.6500	822.6500	779	769	868.2250	823.2250
734	726	867.6625	822.6625	780	770	868.2375	823.2375
735	727	867.6750	822.6750	781	771	868.2500	823.2500
736	728	867.6875	822.6875	782	772	868.2625	823.2625
737	729	867.7000	822.7000	783	773	868.2750	823.2750
738	730	867.7125	822.7125	784	774	868.2875	823.2875
739	731	867.7250	822.7250	785	775	868.3000	823.3000
740	732	867.7375	822.7375	786	776	868.3125	823.3125
741	733	867.7500	822.7500	787	777	868.3250	823.3250
742	734	867.7625	822.7625	788	778	868.3375	823.3375
743	735	867.7750	822.7750	789	779	868.3500	823.3500
744	736	867.7875	822.7875	790	780	868.3625	823.3625
745	737	867.8000	822.8000	791	781	868.3750	823.3750
746	738	867.8125	822.8125	792	782	868.3875	823.3875
747	739	867.8250	822.8250	793	783	868.4000	823.4000
748	740	867.8375	822.8375	794	784	868.4125	823.4125
749	741	867.8500	822.8500	795	785	868.4250	823.4250
750	742	867.8625	822.8625	796	786	868.4375	823.4375
751	743	867.8750	822.8750	797	787	868.4500	823.4500
752	744	867.8875	822.8875	798	788	868.4625	823.4625
753	745	867.9000	822.9000	799	789	868.4750	823.4750
754	746	867.9125	822.9125	800	790	868.4875	823.4875
755	747	867.9250	822.9250	801	791	868.5000	823.5000
756	748	867.9375	822.9375	802	792	868.5125	823.5125
757	749	867.9500	822.9500	803	793	868.5250	823.5250
758	750	867.9625	822.9625	804	794	868.5375	823.5375
759	751	867.9750	822.9750	805	795	868.5500	823.5500
760	752	867.9875	822.9875	806	796	868.5625	823.5625
761	-	868.0000	823.0000	807	797	868.5750	823.5750
762	753	868.0125	823.0125	808	798	868.5875	823.5875
763	-	868.0250	823.0250	809	799	868.6000	823.6000
764	754	868.0375	823.0375	810	800	868.6125	823.6125
765	755	868.0500	823.0500	811	801	868.6250	823.6250
766	756	868.0625	823.0625	812	802	868.6375	823.6375

Program Channel Number	FCC Channel Number	Repeater Transmit Frequency	Repeater Receive Frequency	Program Channel Number	FCC Channel Number	Repeater Transmit Frequency	Repeater Receive Frequency
813	803	868.6500	823.6500	859	-	869.2250	824.2250
814	804	868.6625	823.6625	860	-	869.2375	824.2375
815	805	868.6750	823.6750	861	-	869.2500	824.2500
816	806	868.6875	823.6875	862	-	869.2625	824.2625
817	807	868.7000	823.7000	863	-	869.2750	824.2750
818	808	868.7125	823.7125	864	-	869.2875	824.2875
819	809	868.7250	823.7250	865	-	869.3000	824.3000
820	810	868.7375	823.7375	866	-	869.3125	824.3125
821	811	868.7500	823.7500	867	-	869.3250	824.3250
822	812	868.7625	823.7625	868	-	869.3375	824.3375
823	813	868.7750	823.7750	869	-	869.3500	824.3500
824	814	868.7875	823.7875	870	-	869.3625	824.3625
825	815	868.8000	823.8000	871	-	869.3750	824.3750
826	816	868.8125	823.8125	872	-	869.3875	824.3875
827	817	868.8250	823.8250	873	-	869.4000	824.4000
828	818	868.8375	823.8375	874	-	869.4125	824.4125
829	819	868.8500	823.8500	875	-	869.4250	824.4250
830	820	868.8625	823.8625	876	-	869.4375	824.4375
831	821	868.8750	823.8750	877	-	869.4500	824.4500
832	822	868.8875	823.8875	878	-	869.4625	824.4625
833	823	868.9000	823.9000	879	-	869.4750	824.4750
834	824	868.9125	823.9125	880	-	869.4875	824.4875
835	825	868.9250	823.9250	881	-	869.5000	824.5000
836	826	868.9375	823.9375	882	-	869.5125	824.5125
837	827	868.9500	823.9500	883	-	869.5250	824.5250
838	828	868.9625	823.9625	884	-	869.5375	824.5375
839	829	868.9750	823.9750	885	-	869.5500	824.5500
840	830	868.9875	823.9875	886	-	869.5625	824.5625
841	-	869.0000	824.0000	887	-	869.5750	824.5750
842	-	869.0125	824.0125	888	-	869.5875	824.5875
843	-	869.0250	824.0250	889	-	869.6000	824.6000
844	-	869.0375	824.0375	890	-	869.6125	824.6125
845	-	869.0500	824.0500	891	-	869.6250	824.6250
846	-	869.0625	824.0625	892	-	869.6375	824.6375
847	-	869.0750	824.0750	893	-	869.6500	824.6500
848	-	869.0875	824.0875	894	-	869.6625	824.6625
849	-	869.1000	824.1000	895	-	869.6750	824.6750
850	-	869.1125	824.1125	896	-	869.6875	824.6875
851	-	869.1250	824.1250	897	-	869.7000	824.7000
852	-	869.1375	824.1375	898	-	869.7125	824.7125
853	-	869.1500	824.1500	899	-	869.7250	824.7250
854	-	869.1625	824.1625	900	-	869.7375	824.7375
855	-	869.1750	824.1750	901	-	869.7500	824.7500
856	-	869.1875	824.1875	902	-	869.7625	824.7625
857	-	869.2000	824.2000	903	-	869.7750	824.7750
858	-	869.2125	824.2125	904	-	869.7875	824.7875

Program Channel Number	FCC Channel Number	Repeater Transmit Frequency	Repeater Receive Frequency	
905	-	869.8000	824.8000	
906	-	869.8125	824.8125	
907	-	869.8250	824.8250	
908	-	869.8375	824.8375	
909	-	869.8500	824.8500	
910	-	869.8625	824.8625	
911	-	869.8750	824.8750	
912	-	869.8875	824.8875	
913	-	869.9000	824.9000	
914	-	869.9125	824.9125	
915	-	869.9250	824.9250	
916	-	869.9375	824.9375	
917	-	869.9500	824.9500	
918	-	869.9625	824.9625	
919	-	869.9750	824.9750	
920	-	869.9875	824.9875	

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